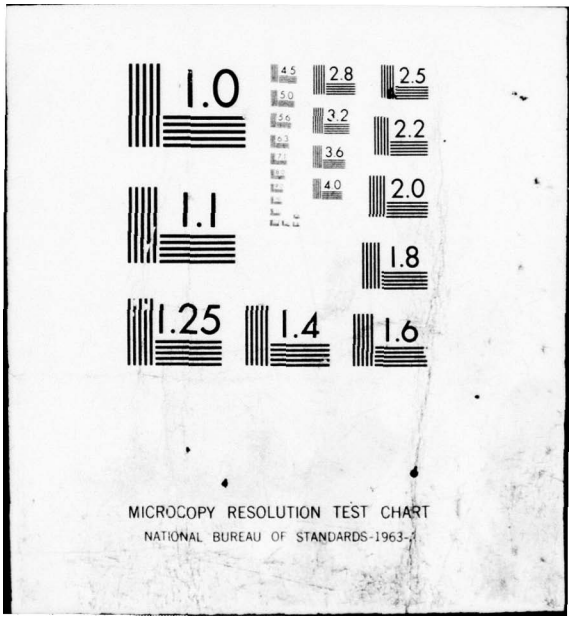
AD-A069 906 NEW JERSEY STATE DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. CLEMENTON LAKE DAM (NJ00410), DELA--ETC(U)
MAY 79 R J MCDERMOTT DACW61-78-C-0124

UNCLASSIFIED 1 OF 2

AD A069906


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LEVEL

DELAWARE RIVER BASIN
NORTH BRANCH BIG TIMBER CREEK
CAMDEN COUNTY
NEW JERSEY

AD A069906

CLEMENTON LAKE DAM
NJ 00410

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Approved for public release;
distribution unlimited

ORIGINAL CONTAINS COLOR PLATES: ALL DDC
REPRODUCTIONS WILL BE IN BLACK AND WHITE.

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

May, 1979

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DDC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NJ00410
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): Phase I Inspection Report
National Dam Safety Program
Clementon Lake Dam
Camden County, N.J.

5. TYPE OF REPORT & PERIOD COVERED: (9) FINAL rept.

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): (10) Richard J. McDermott, P.E.

8. CONTRACT OR GRANT NUMBER(s): (15) DACW61-78-C-0124

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Storch Engineering Co.
220 Ridgedale Ave.
Florham Park, N.J. 07932

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (12) 106p.

11. CONTROLLING OFFICE NAME AND ADDRESS
U.S. Army Engineer District, Philadelphia
Custom House, 2d & Chestnut Streets
Philadelphia, Pennsylvania 19106

12. REPORT DATE: (11) May 1979

13. NUMBER OF PAGES: 75

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (6) National Dam Safety Program. Clementon Lake Dam (NJ-00410), Delaware River Basin, North Branch Big Timber Creek, Camden County, New Jersey. Phase 1 Inspection Report.

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams
Spillways
Riprap
Roadway Pavement
Embankments
Structural Analysis
Visual Inspection
National Dam Inspection Act Report
Clementon Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

JOB

410 891

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Clementon Lake Dam in Camden County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Clementon Lake Dam, a high hazard potential structure, is judged to be in good overall condition. However, the dam's spillway is considered inadequate since 3 percent of the Spillway Design Flood -SDF- would overtop the dam. (The SDF, in this instance is one half of the Probable Maximum Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the fact that failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system, should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. The following remedial actions should be completed within six months from the date of approval of this report:

(1) Remove all trees and brush on the embankment with minimal disturbance of the ground surface in order to reduce the piping potential.

(2) Repair eroded areas and the broken and cracked roadway pavement on the upstream slope of the dam. Riprap should be placed along this slope to protect it against wave attack and drainage induced erosion.

(3) Thoroughly inspect the timber spillway and the bridge. Rotted timbers should be replaced and cracks and spalling in the bridge structure and wingwalls should be grouted and sealed.

(4) Inspect and repair the opening observed in the stone drywall southwest of the bridge.

(5) A topographic survey should be made to establish the existing conditions at the dam.

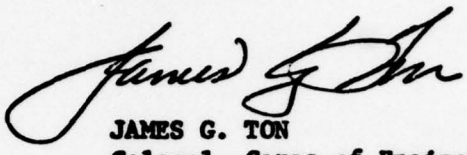
A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James J. Florio of the First District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

NAPEN-D
Honorable Brendan T. Byrne

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,



JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

CLEMENTON LAKE DAM (NJ00410)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 18 December 1978 by Storch Engineering under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Clementon Lake Dam, a high hazard potential structure, is judged to be in good overall condition. However, the dam's spillway is considered inadequate since 3 percent of the Spillway Design Flood -SDF- would overtop the dam. (The SDF, in this instance is one half of the Probable Maximum Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the fact that failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system, should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. The following remedial actions should be completed within six months from the date of approval of this report:

(1) Remove all trees and brush on the embankment with minimal disturbance of the ground surface in order to reduce the piping potential.

(2) Repair eroded areas and the broken and cracked roadway pavement on the upstream slope of the dam. Riprap should be placed along this slope to protect it against wave attack and drainage induced erosion.

(3) Thoroughly inspect the timber spillway and the bridge. Rotted timbers should be replaced and cracks and spalling in the bridge structure and wingwalls should be grouted and sealed.

(4) Inspect and repair the opening observed in the stone drywall southwest of the bridge.

(5) A topographic survey should be made to establish the existing conditions at the dam.

APPROVED: James G Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 30 May 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Clementon Lake Dam, NJ00410
State Located:	New Jersey
County Located:	Camden
Drainage Basin:	Delaware River
Stream:	North Branch, Big Timber Creek
Date of Inspection:	December 18, 1978

Assessment of General Condition of Dam

Clementon Lake Dam is in good overall condition, and outwardly structurally stable, however the hydraulic capacity of the spillway is inadequate. The SDF (Spillway Design Flood) for Clementon Lake Dam is 1/2 PMF. The spillway at the dam is capable of passing approximately one percent of the PMF without overtopping the dam.

It was also determined that the immediate downstream channel, consisting of a concrete trapezoidal channel is hydraulically adequate to accommodate the SDF peak flow.

The owner should engage a qualified professional engineer soon to accurately analyze the hydrologic and hydraulic characteristics of the dam and then design modifications to the dam and spillway so that the spillway is capable of accommodating the SDF (Spillway Design Flood).

A comprehensive topographic survey should be performed to establish the existing conditions at the dam.

The following remedial work is recommended to be performed in the near future:

1) All trees and brush on the embankment should be removed with minimal disturbance of the ground surface.

2) Eroded areas and the broken and cracked roadway pavement on the upstream slope of the dam should be repaired. Riprap should be placed along this slope to protect it against wave attack and drainage induced erosion.

3) The timber spillway and the bridge should be thoroughly inspected. Rotted timbers should be replaced and cracks and spalling in the bridge structure and wingwalls should be grouted and sealed.

4) The opening observed in the stone drywall southwest of the bridge should be inspected and repaired.

The owner's annual inspection and maintenance program should be continued. However, inspections should be performed by a qualified professional engineer. Observations, measurements and remedial measures should be recorded in a permanent file available for public inspection. Annual maintenance should include removal of brush and trees from the embankment and repair of riprap slope protection after it has been placed on the upstream face of the dam.

Richard J. McDermott

Richard J. McDermott, P.E.

OVERVIEW - CLEMENTON LAKE DAM

18 Dec. 1978

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 30214. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CLEMENTON LAKE DAM I.D. NJ00410

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United Sates. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

Clementon Lake Dam was inspected on December 18, 1978 to generally assess the structural integrity and operational adequacy of the dam and appurtenances.

1.2 Description of Project

a. Description of Dam and Appurtenances

The facilities at Clementon Lake Dam consist of an earthfill embankment and one controlled spillway consisting of three timber slide gates (see Plates 4 and 5 and Overview Photo).

Discharge from the spillway flows under Camden County Bridge E8-10; which is at the northeast end of the dam and into a concrete trapezoidal channel portion of the North Branch of Big Timber Creek.

The earthfill embankment is about 375 feet long with its crest at elevation 56.7 (MSL) and is aligned approximately northeast/southwest. The embankment crest is surfaced with an asphalt paved roadway approximately 30 feet wide over most of its length and about 27 feet wide at the bridge. The upstream embankment slope is about 2.5 horizontal to 1 vertical from the pavement edge to the water line. Surface soil on the side slopes is sandy and is partially covered with sparse grass in the form of large tufts. The downstream embankment slope is about 3.5 horizontal to 1 vertical for a vertical height of about 4 feet. the area downstream from the embankment toe consists of an undeveloped gradually sloping area with sparse grass cover.

The spillway consists of three timber slide gates fitted in a timber frame located on the upstream side of Camden County Bridge No. 8E-10. The gates normally function as

an overflow weir with a total crest length of about 12.8 feet. The tops of the gates are at elevation 54.0, about 2.7 feet below the dam crest. The slide gates also serve as outlet works with maximum opening heights of about 5.3 feet. The gate inverts are at elevation 51.0 about 2.3 feet above the invert of the discharge culvert.

The spillway discharges through the opening under Camden County Bridge No. 8E-10. This bridge consists of a reinforced concrete structure that was reconstructed in 1938. The cross-sectional area under the bridge is about 14.5 feet wide by 7 feet high. The area is partially obstructed at the upstream side by an 8 inch diameter cast iron water pipe spanning the width of the opening. The pipe is located about 2.5 feet below the underside of the bridge deck.

Discharge from the spillway flows under the bridge, and down a concrete channel transition section at the downstream end of the bridge to the downstream concrete trapezoidal channel. The trapezoidal channel consists of a low-flow depressed center area 4.8 feet wide by 1.7 feet deep, flanked by horiztonal areas about 6 feet wide. The sides of the channel slope up at about 2.3 horizontal to 1 vertical with a vertical height of 5.7 feet. The channel invert at the downstream end of the bridge is at elevation 38.6. The concrete trapezoidal channel continues for about 300 feet, where it passes under two road bridges. Beyond the second bridge discharge flows into a natural earth channel.

b. Location

Clementon Lake Dam impounds Clementon Lake and is situated at the northwest end of the lake. The dam is located across the North Branch of Big Timber Creek, in the Borough of Clementon, Camden County, N. J.

c. Size and Hazard Classification

Size and Hazard Classification criteria presented in "Recommended Guidelines for Safety Inspection of Dams", published by the U.S. Army Corps of Engineers are as follows:

SIZE CLASSIFICATION

	Impoundment	
Category	Storage (Ac-ft)	Height (Ft)
Small	<1000 and ≥ 50	<40 and ≥ 25
Intermediate	≥ 1000 and $<50,000$	≥ 40 and <100
Large	$\geq 50,000$	≥ 100

HAZARD POTENTIAL CLASSIFICATION

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Development)
Low	None expected (no permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than few	Excessive (Extensive community, industry or agriculture)

The characteristics of Clementon Lake Dam are:

Storage = 79 acre-feet (at top of dam)

Height = 18 feet

Potential Loss of Life: Approximately 12 commercial and residential structures located within the downstream SDF flood plain.

Potential Economic Loss: Two road bridges about 300 and 500 feet downstream. Commercial and residential development within the downstream flood plain.

Therefore, Clementon Lake Dam is classified as "Small" size and "High" hazard potential.

d. Ownership

Clementon Lake Dam is owned by Clementon Lake Park, Inc., P.O. Box 176, Clementon, New Jersey 08021.

e. Purpose of Dam

Clementon Lake Dam originally was constructed to impound water to power a gristmill. Reportedly, the impoundment use was changed to recreational use in 1907.

f. Design and Construction History

There is no information available for the original design and construction of the dam or appurtenances. Reportedly, the dam was built in the mid 1800's and has been altered periodically as required.

New slide gates were installed in 1925 after the spillway was damaged by flooding caused by the failure of an upstream dam. Reportedly, the dam has not been breached since it was constructed, however it was overtopped once in 1940 when the upstream dams failed. Depth of flow over the dam was reported to be about 3 inches, but there was no damage to the dam or appurtenances.

The center gate at the spillway was equipped with a lifting mechanism in 1942. Presently all of the gates have lifting mechanisms.

The bridge at the northeast end of the dam was reconstructed in 1938. One construction drawing for this bridge was obtained from the Camden County Engineering Department. This drawing indicates replacement of the bridge superstructure.

g. Normal Operational Procedures.

The ownership of the lake and dam was transferred to Clementon Lake Park, Inc. in March 1977. Reportedly, the operational procedures established by the present owner are: 1) to monitor and record the lake level periodically, as frequently as hourly during intense storms, and 2) to open the gates to lower the lake level as required during these periods.

The lake level is lowered annually in September and remains at that level until the end of March. During this period the lake basin is cleaned, docks are repaired and the dam and appurtenances are inspected. Repairs are performed "as-needed". No repair work has been performed on the dam or appurtenances since 1977.

Reportedly, the crest road is owned and maintained by the Borough of Clementon and the bridge at the northeast end of the dam is owned and maintained by Camden County.

1.3 Pertinent Data

a. Drainage Area - 2.8 square miles

b. Discharge at Damsite

Maximum Known Flood at damsite	1940 (Dam overtopped)
Outlet works at pool elevation	112 c.f.s.
Diversion tunnel low pool outlet at pool elevation	N.A.
Diversion tunnel outlet at normal pool elevation	N.A.
Gated spillway capacity at normal pool elevation	4 c.f.s. (Estimated)
Gated spillway capacity at top of dam	163 c.f.s.
Ungated spillway capacity at top of dam	N.A.
Total spillway capacity at top of dam	163 c.f.s.

c. Elevation (Feet above MSL)

Top of Dam	56.7
Maximum pool-design surcharge	58.8
Full flood control pool	N.A.
Recreation pool	54.0
Spillway crest	54.0
Upstream portal invert diversion tunnel	N.A.
Stream bed at centerline of dam	48.7
Maximum tailwater	45 (Estimated)

d. Reservoir

Length of maximum pool	2200 feet
Length of recreation pool	1800 feet
Length of flood control pool	N.A.

e. Storage (Acre-feet)

Recreation pool	28 acre-feet
Flood control pool	N.A.
Design surcharge	131 acre-feet
Top of dam	79 acre-feet

f. Reservoir Surface (acres)

Top of Dam	22 acres (estimated)
Maximum pool	27 acres (estimated)
Flood control pool	N.A.
Recreation pool	16 acres
Spillway crest	16 acres

g. Dam

Type	Earthfill
Length	375 feet
Height	18 feet
Side slopes - Upstream	2.5 horiz. to 1 vert.
Downstream	3.5 horiz. to 1 vert.
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

h. Diversion and Regulating Tunnel — N.A.

i. Spillway

Type	Timber slide gates
Length of weir	12.8 feet
Crest elevation	54.0
Gate	Manual Slide Gates, (3 gates, 4.3' wide by 3.0' high)
Upstream channel	N.A.
Discharge Culvert	Bridge opening (7'high by 14.5'wide)
Downstream Channel	Trapezoidal Concrete Channel

j. Regulating Outlets — Manual slide gates (above)

SECTION 2: ENGINEERING DATA

2.1 Design

There is no engineering data available for the dam or the spillway. One construction drawing was obtained from Camden County Engineering Department for reconstruction of the superstructure for the bridge at the northeast end of the dam.

2.2 Construction

There are no records available for the construction or repair of the dam or appurtenances. A "Reference Data" form obtained from the Camden County Engineering Department indicates that the dam was repaired in 1925 after it was damaged by a flood. Reportedly, the slide gates on the spillway were replaced about 15 years ago and a steel sheet pile wall was installed along the upstream embankment slope to protect it against erosion caused by power boat wakes.

2.3 Operation

Reportedly, the present owner is keeping general operational records. These records consist of information pertaining to monitoring of the water level and operation of the slide gates. The lake level is lowered annually from September to March to permit cleaning of the lake, repair of docks and inspection and repair of the dam and appurtenances.

One dam inspection report was on file with the Camden County Engineering Department for an inspection performed on May 1, 1974. The report indicates that the dam was generally in sound condition; and it was recommended that riprap be placed on the upstream slope and a crack in the upstream part of the spillway be grouted. No evidence of the riprap was observed during the field inspection.

2.4 Evaluation

a. Availability

Engineering data for the original dam and appurtenances are not available. One drawing for the reconstruction of the bridge superstructure for the bridge at the northeast end of the dam is available from the Camden County Engineering Department.

b. Adequacy

Engineering data pertaining to Clementon Lake Dam is not adequate to be of significant assistance in performing a Phase I assessment.

c. Validity

The single construction drawing for the 1938 reconstruction of the bridge at the northeast end of the dam was generally accurate with respect to the as-built conditions observed during the field imspection.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The inspection of Clementon Lake Dam was performed on December 18, 1978 by members of the staff of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1.

The following procedures were employed for the inspection:

1. The embankment of the dam, appurtenant structures and adjacent areas were examined.
2. The embankment and appurtenant structures were measured and key elevations were determined by hand level.
3. The embankment, appurtenant structures and adjacent areas were photographed.

Information presented in the following paragraphs of this Section consists of observations made during the field inspection.

b. Dam

The dam was observed to be in good condition. The embankment is generally straight and level over its 375 feet of length with no noticeable localized depressions. The remains of the above ground portions of a steel sheet pile slope protection were observed lying along the

upstream slope of the embankment. The sheets had apparently rusted through at the normal water level. There was no evidence of riprap protection along the upstream slope as had been recommended in the 1974 dam inspection report and the slope was still in need of stabilization. Longitudinal cracks were noted in the bituminous roadway pavement on the upstream edge of the dam crest. Areas were observed where pavement had been undermined and broken away at the upstream edge. This damage was apparently due to poor road drainage and perhaps wave action.

Most of the embankment slopes were covered with sparse grass in the form of large tufts. A few small trees were noted on the downstream embankment slope. No animal burrows were observed along any portion of the dam.

A diagonal opening was observed at the bottom of a stone dry wall in the northeast bridge abutment on the downstream face. There were no signs of distress in the dry wall nor seepage from the opening.

Two pipes outlet on the downstream face of the embankment, one on each side of the bridge abutments. The pipe on the southwest side of the bridge was dry and apparently drained a roadside catch basin on that side of the bridge. Water was flowing from the pipe on the northeast side of the bridge. The source of the water could not be determined at the time of the inspection. Both pipes were connected to the downstream channel with short concrete paved swales.

Generally, surficial soils at the dam site consist of silt and sand with some clay, and significant organic

matter. Underlying soils are composed of sand with interbedded silty sand, known as Kirkwood Sands formed during the Tertiary Period. Bedrock is generally more than 100 feet below the surface.

c. Appurtenant Structures

Spillway

The spillway structure consists of 3 timber slide gates mounted in a timber frame, all of which were in good condition. Reportedly, all of the gates are operable. The lake was drawn down about 2.5 feet at the time of the inspection, exposing most of the height of the gates. The northeasterly gate was open to a height of about 1.5 feet and the invert was submerged by overflow.

Discharge Culvert

The discharge structure, consisting of Camden County Bridge E8-10(1939), was observed to be in fair condition. Spalling was noted on the concrete surfaces on the downstream bridge wingwalls.

Timber members were inset in the lower portions of the vertical concrete abutment walls. These members were apparently nailers for timber facia planks and serve no structural purpose. Both the inset timbers and the planks were deteriorated and in very poor condition.

d. Reservoir Area

Clementon Lake is apporximately 1800 feet long and about 400 feet wide. About two-thirds of the immediate shoreline is developed with private residences and the remainder is developed as Clementon Lake Amusement Park. The residential shoreline generally slopes up at between 2 and 12 percent from the lake. There are several small boat docks along the residential shoreline. Most of the amusement park shoreline is fronted with a reinforced concrete retaining wall. The amusement park also has one boat pier, two swimming platforms and a diving platform.

e. Downstream Channel

Discharge from Clementon Lake enters a trapezoidal concrete channel that extends about 300 feet to two downstream road bridges, beyond which the channel remains in a natural condition. The downstream channel is known as the North Branch of Big Timber Creek which flows through a densely populated portion of the Borough of Clementon.

The trapezoidal channel consists of a low-flow depressed center section 4.8 feet wide and 1.7 feet deep. The channel bottom extends horizontally from the depressed section, about 6 feet on each side. The sides of the channel slope up at 2.3 horizontal to 1 vertical, a vertical height of about 5.7 feet.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The water level in Clementon Lake Dam is normally naturally controlled by overflow at the timber slide gates. Reportedly, during intense storms the lake level is monitored frequently and the slide gates are opened to maintain a lower lake level. Experience has shown that it takes about 2 days to draw the lake down.

4.2 Maintenance of Dam

Apparently maintenance of the dam is shared. The owner, Clementon Lake Park, maintains the spillway and the earth embankment. The Borough of Clementon maintains the crest roadway and Camden County maintains the bridge at the spillway.

Reportedly, the lake is drawn down annually from September to March. During this period the embankment and spillway are inspected and repaired. There are no records available documenting the work performed in the past.

Repairs are generally performed on the crest roadway and the bridge on an"as-needed" basis. There are no records available for repairs performed on the crest roadway. The last recorded maintenance performed on the bridge is the 1938 reconstruction of the superstructure.

Reportedly, the steel sheet piles along the upstream dam slope were installed about 15 years ago as slope protection to prevent erosion caused by power boat wakes. This sheeting has been neglected and allowed to deteriorate due to the absence of power boat traffic on the lake in the recent past.

Judging from the present condition of the dam and appurtenances, overall maintenance by the three groups mentioned above has been adequate with the exception of the following areas:

1) Steel sheet piles on the upstream embankment slope rusted through.
2) Crest road pavement on upstream side cracked and broken from erosion of adjacent slope.
3) Timber nailers and facia planks on bridge abutment walls deteriorated.
4) Spalled concrete surfaces on wingwalls downstream of bridge.

4.3 Maintenance of Operating Facilities

Reportedly, the slide gates at the dam are inspected and maintained annually, and all are presently operable. Documentation for the maintenance performed on these facilities is not available.

4.4 Description of Warning System

There is no formal warning system for the dam. The lake level is monitored periodically, and as frequently as hourly during intense storms. The slide gates at the spillway are opened to maintain a lower level in the lake during these periods, however there is no policy of informing the local authorities or the population along the downstream channel of operational changes or impending danger.

4.5 Evaluation of Operational Adequacy

The overall condition of the dam, operating facilities and other appurtenances is good. Maintenance has been adequate, except in the above noted areas. Maintenance documentation has been poor. The lake level monitoring system as described by the owner is adequate for operation of the gates, but the local authorities should be informed of major actions or potentially dangerous conditions.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

Size and hazard classification were used in conjunction with "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers to establish the SDF (Spillway Design Flood) for Clementon Lake Dam. The appropriate design range for this facility is 1/2 PMF to PMF (Probable Maximum Flood). Since the characteristics for Clementon Lake Dam as described in Section 1, fall in the lower end of the prescribed range, the 1/2 PMF is used as the SDF.

The inflow hydrograph for Clementon Lake Dam was calculated using the Soil Conservation Service Triangular Unit Hydrograph with the curvilinear transformation and the HEC-1-DB computer program. General hydrologic characteristics used in this method were computed using USGS quadrangles and aerial photographs. The drainage area contributing to Clementon Lake is 2.8 square miles. Most of the watershed is sparsely developed with cranberry bogs, woodland, and three upstream lakes. Reservoir storage capacities were estimated using surface areas measured from USGS quadrangles. Discharge hydraulics for the spillway were computed considering the slide gates as sharp-crested weirs up to the top of the openings and as submerged orifices for higher water levels (see Appendix 4).

The SDF inflow hydrograph was routed through the spillway at Clementon Lake Dam using the HEC-1-DB computer program which indicated that the dam would be overtopped.

Computations show that overtopping in a non-breach condition would occur for about 11 hours with a maximum flow height above the dam crest of 2.1 feet and a maximum discharge of 4,982 c.f.s. It was also computed that the existing spillway is adequate for a maximum storm equivalent to 1 percent of the PMF without overtopping the dam.

b. Experience Data

Reportedly, Clementon Lake Dam has not been breached since it was constructed in the mid 1800's and has been overtopped once in 1940 with no damage.

c. Visual Observation

At the time of the field inspection there was no evidence of recent overtopping of the dam.

d. *Overtopping Potential*

As indicated above, a storm of magnitude equal to the SDF would cause overtopping of the dam to a height of about 2.1 feet with a peak discharge of 4,982 c.f.s. in a non-breach condition.

Based on field observation, overtopping of Clementon Lake Dam would develop along the entire dam crest (375 feet), except at the bridge (approximated 50 feet). Overtopping would also occur along the lake shoreline southwest of the dam which is level and at the same elevation as the dam crest for about 250 feet. Therefore, the effective overtopped length for the dam would be approximately 575 feet.

The high water levels that would be associated with an overtopping condition would probably breach the dam. Based on field inspections the breach would probably occur in the area southwest of the spillway and would not have a bottom elevation below elevation 52.8 (approx. elevation of downstream toe southwest of trapezoidal channel). The breach condition was analyzed with the HEC-1-DB computer program and it was computed that overtopping of the dam would develop to a maximum height of 0.9 feet above the dam crest and a maximum discharge of 4,986 c.f.s. would occur. Based on the configuration of the large flat undeveloped area immediately downstream of most of the embankment and the estimated lowest breach bottom elevation of 52.8, the hydraulic head differential that would exist during a breach would be small and breach discharge would spread out over a very broad area draining to the concrete trapezoidal channel. The trapezoidal channel will accommodate the peak breach discharge, and will maintain a low level of flooding immediately downstream of the dam. The breach discharge would be passed to the natural downstream channel and would result in flood of about the same magnitude as would result from an overtopping condition.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The embankment and appurtenances appeared to be structurally stable at the time of the field inspection with no major cracks, displacement or settlement.

b. Design and Construction Data

Information pertaining to structural stability analyses and construction of the dam is not available for the dam or appurtenances.

c. Operating Records

Operating records are being kept for gate operation by the present owner. No records were kept prior to 1976. Data pertaining to maintenance of the dam and appurtenances are not available.

d. Post Construction Changes

Based on the "Reference Data" obtained from the Camden County Engineering Department, the spillway was repaired in 1925 after being damaged by a flood. New gates were installed at the spillway in April 1925, and an operating mechanism was installed on the center gate in 1942. Steel sheet pile slope protection was installed along the upstream embankment slope about 20 years ago and has since rusted through at the normal pool elevation.

The superstructure of the bridge forming the discharge culvert for the spillway was reconstructed in 1938, but the discharge area beneath the bridge was not changed substantially.

e. Seismic Stability

Clementon Lake Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams," which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading, if stable under static loading conditions. Based on observation made during the field inspection, Clementon Lake Dam outwardly appeared to be stable under static loading conditions.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on the hydraulic and hydrologic analyses described in Section 5, and Appendix 4 the spillway at Clementon Lake Dam is hydraulically inadequate and capable of passing flows equal to about one percent of the PMF without overtopping the dam. A storm equivalent to the SDF (1/2 PMF) would probably overtop and breach the dam, resulting in increased outflow and release of stored runoff.

Field conditions dictate that the breach configuration would be broad and relatively shallow, outflowing to an undeveloped flat grassed area. Under projected breach conditions peak discharge would not exceed the capacity of the trapezoidal channel and would be passed to the natural downstream channel causing inundation of the downstream flood plain.

Outwardly, the facilities at Clementon Lake Dam appear to be structurally stable, based on field inspection observations.

b. Adequacy of Information

Information sources for this study include: 1) field investigations, 2) Plan titled "Reinforced Concrete Deck" dated December 1938, prepared by S. Herbert Taylor, Camden County Engineer, 3) USGS quadrangles, 4) aerial photographs for Camden County and 5) consultation with owner.

Information available and data collected for Clementon Lake Dam are sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some data not available are as follows:

1. Records of maintenance for the dam and appurtenances.
2. Typical earth embankment sections.
3. Structural and hydraulic design computations and reports.
4. Soils report for the site.
5. Records of post construction changes.

c. Necessity for Additional Data/Evaluation

Although some data pertaining to Clementon Lake Dam are not available, additional data are not considered imperative for this Phase I evaluation.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses performed for this report, the spillway is assessed as inadequate. It is therefore recommended that, a qualified professional engineer be engaged soon to more accurately analyze the runoff characteristics of the watershed, the hydraulic capacity of the spillway and the capacity of the downstream channel area. Based on the findings of these analyses

modifications to the dam and spillway should be designed. The following alternatives should be considered:

1) Improve the present spillway to accommodate the routed SDF flow rates.

2) Construct additional outlet facilities in the form of auxiliary spillways and emergency spillways.

It is further recommended that the following measures be undertaken by the parties responsible for maintenance in the near future:

1) All trees and brush on the embankment should be removed with minimal disturbance of the ground surface.

2) Eroded areas and the broken and cracked roadway pavement on the upstream slope of the dam should be repaired. Riprap should be placed along the upstream slope to protect it against wave attack and drainage induced erosion.

3) The timber spillway and the bridge should be thoroughly inspected. Rotted timbers should be replaced and cracks and spalling in the bridge structure and wingwalls should be grouted and sealed.

4) The opening observed in the stone drywall southwest of the bridge should be inspected and repaired.

The implementation of the above measures will require proper detailed design and that applicable NJDEP approvals be obtained.

b. Maintenance

The owners' annual inspection and maintenance program including drawing the lake down should be continued, however the inspections should be performed by a qualified professional engineer. Observations and measurements should be recorded on standardized check-list forms and included in a permanent file along with records of maintenance work performed. This permanent file should be available for public inspection. Repairs should be performed as required and the following maintenance should be performed annually: remove brush and trees from the embankment, reshape riprap along upstream slope after it has been placed and add material where needed.

c. Additional Studies

A qualified professional engineer should be engaged soon to perform a more sophisticated hydrologic and hydraulic analysis of the watershed and the spillway, and to design modifications to the spillway so that a storm equivalent to the SDF can be accommodated.

A comprehensive topographic survey of the dam and appurtenances should be performed in the near future by a licensed land surveyor to establish the present conditions. This survey should be included in the owner's permanent file for the dam.

PLATES

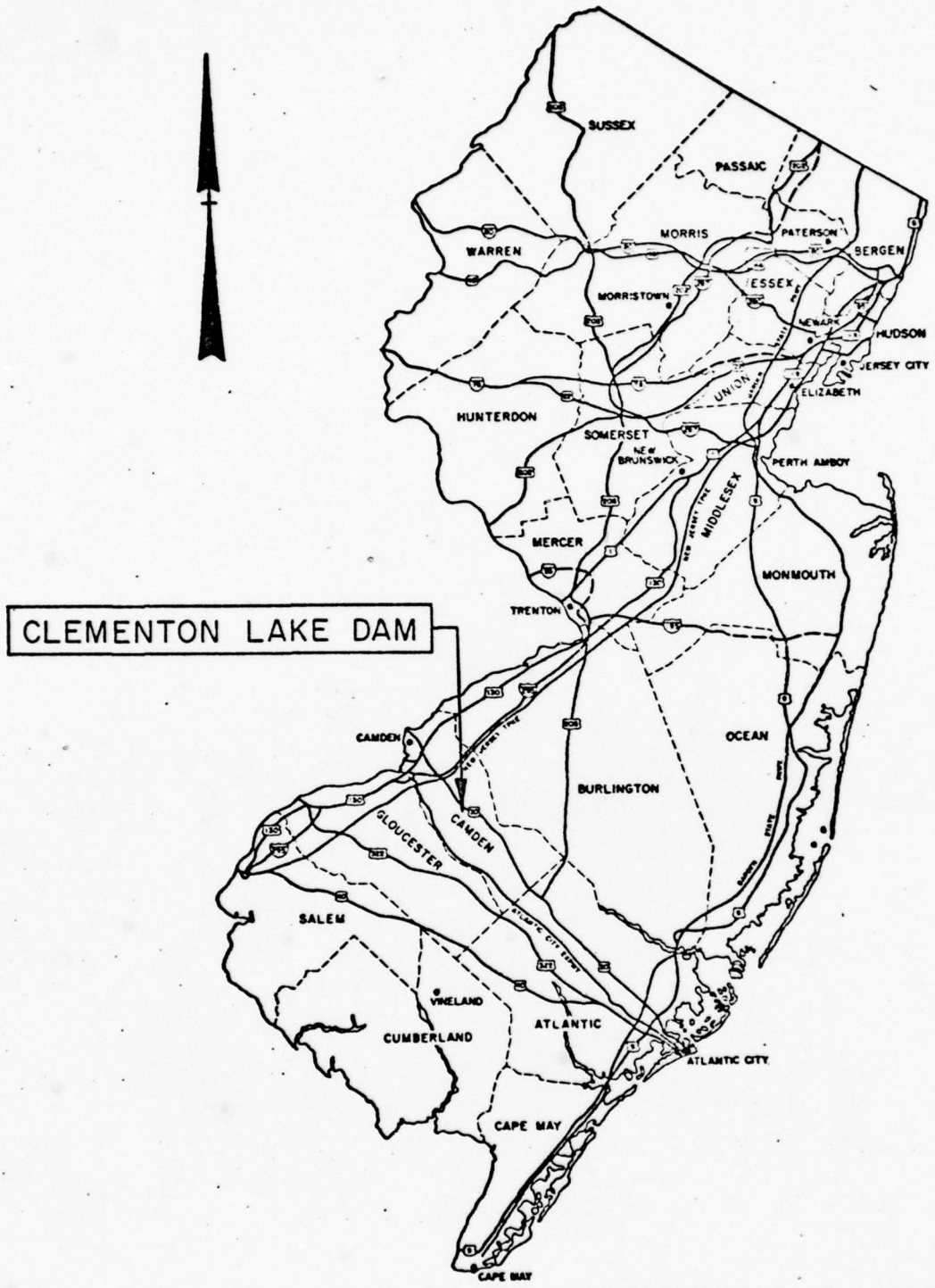


PLATE 1

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

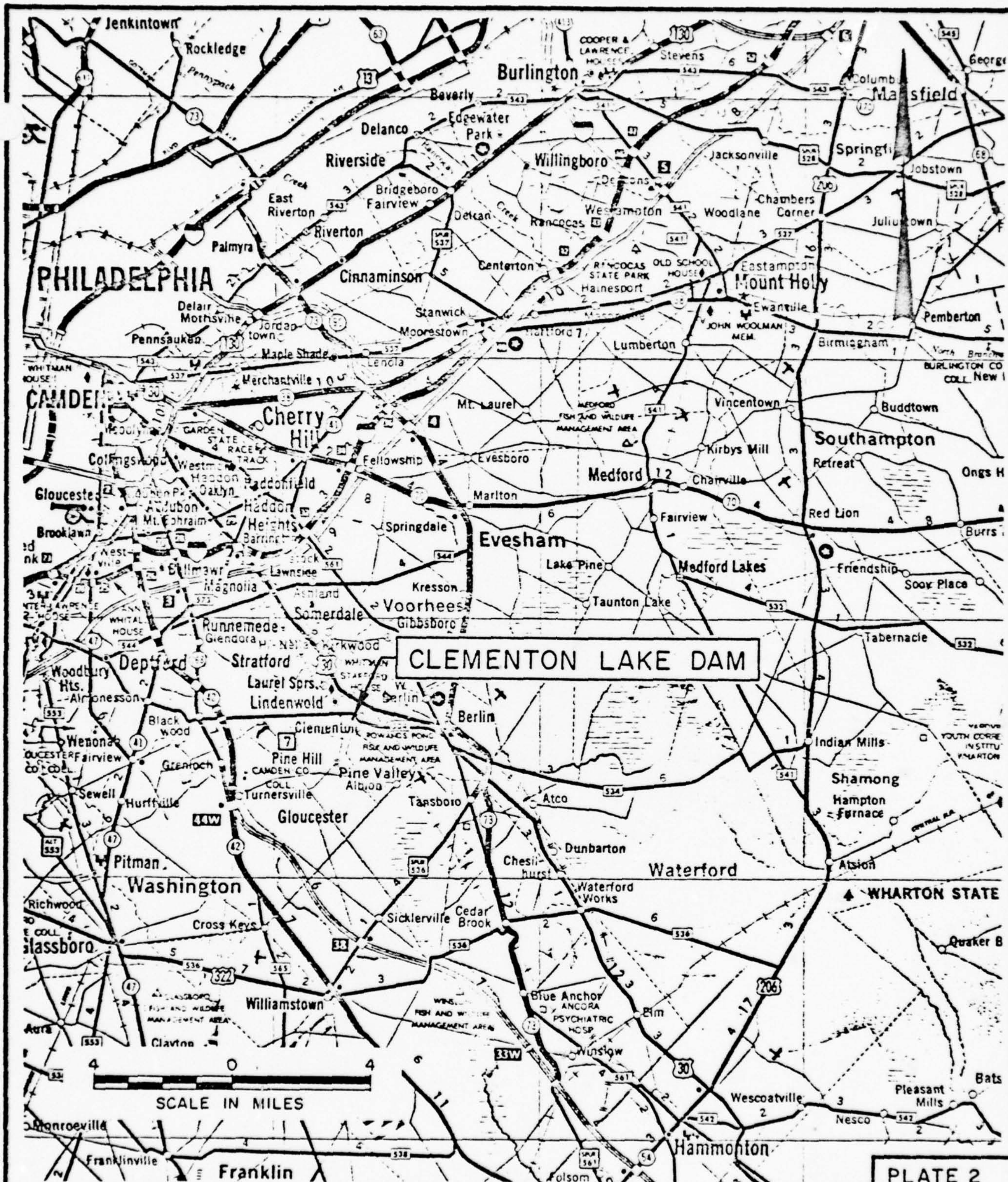
KEY MAP

CLEMENTON LAKE DAM

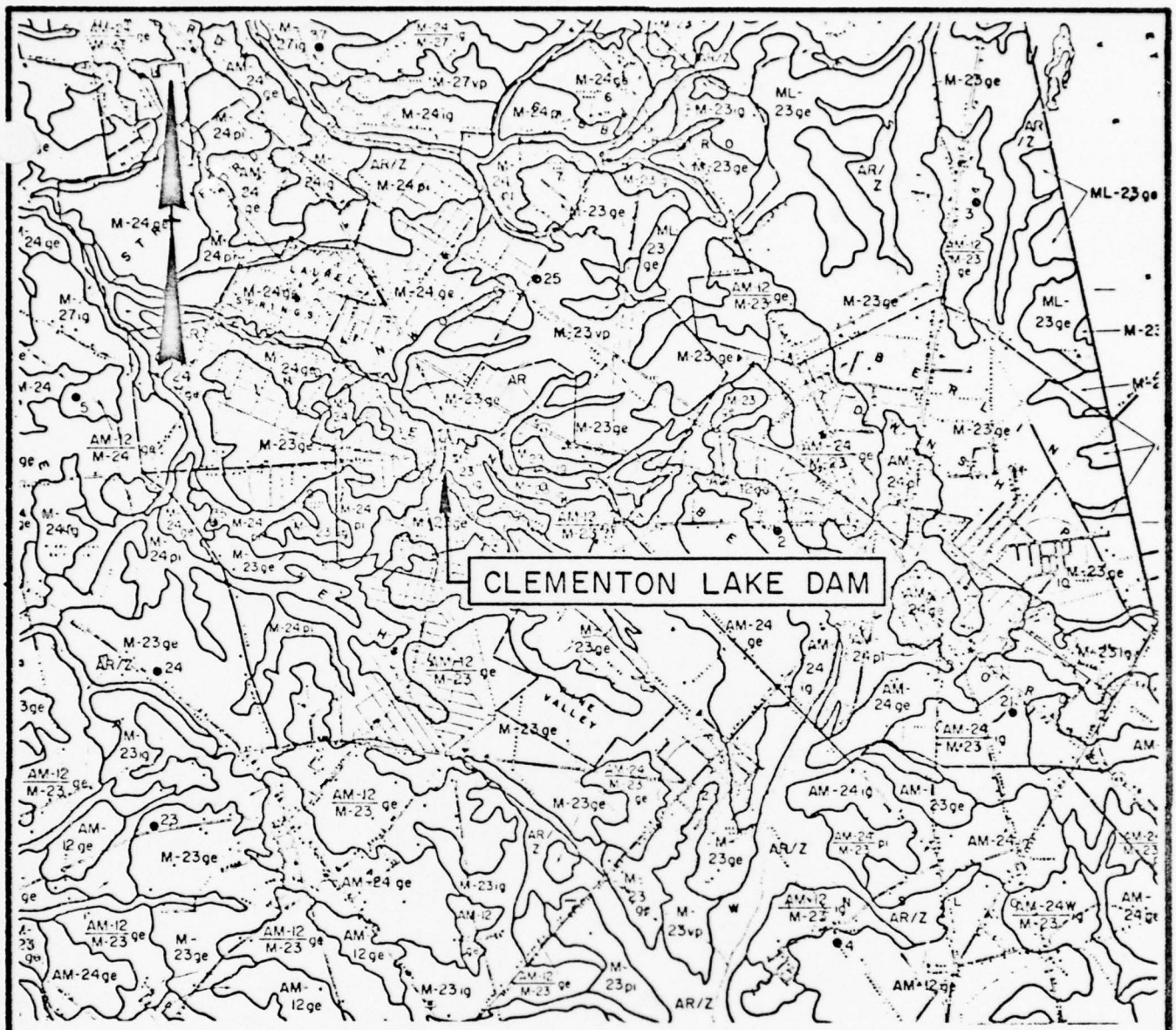
I.D. N.J. 00410

SCALE: NONE

DATE: MARCH, 1979



STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS **VICINITY MAP** CLEMENTON LAKE DAM	
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. N.J. 00410	SCALE: AS SHOWN DATE: MARCH, 1979



Legend

AR	Silt and sand with some clay and a significant amount of organic matter near the surface.
MV-23	Sand with interbedded silty sand.(Kirkwood Sands)

Note: Information taken from Rutgers University Soil Survey of New Jersey, Report No. 17, Camden County and Geologic Map of New Jersey prepared by Lewis and Kummel.

PLATE 3

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

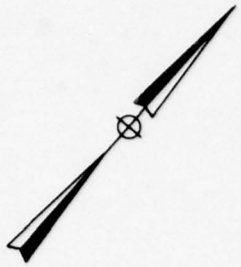
SOIL MAP

CLEMENTON LAKE DAM

I.D. N.J. 00410

SCALE: NONE

DATE: MARCH, 1979



Downstream Fac
of Embankmen

Paved Road

Deteriorated Steel
Sheet Piling

Ups
of E

Dam Crest Length 3

CLEMENTON LAKE

NOTE:
Information taken from Field
inspection December 18, 1978.

1

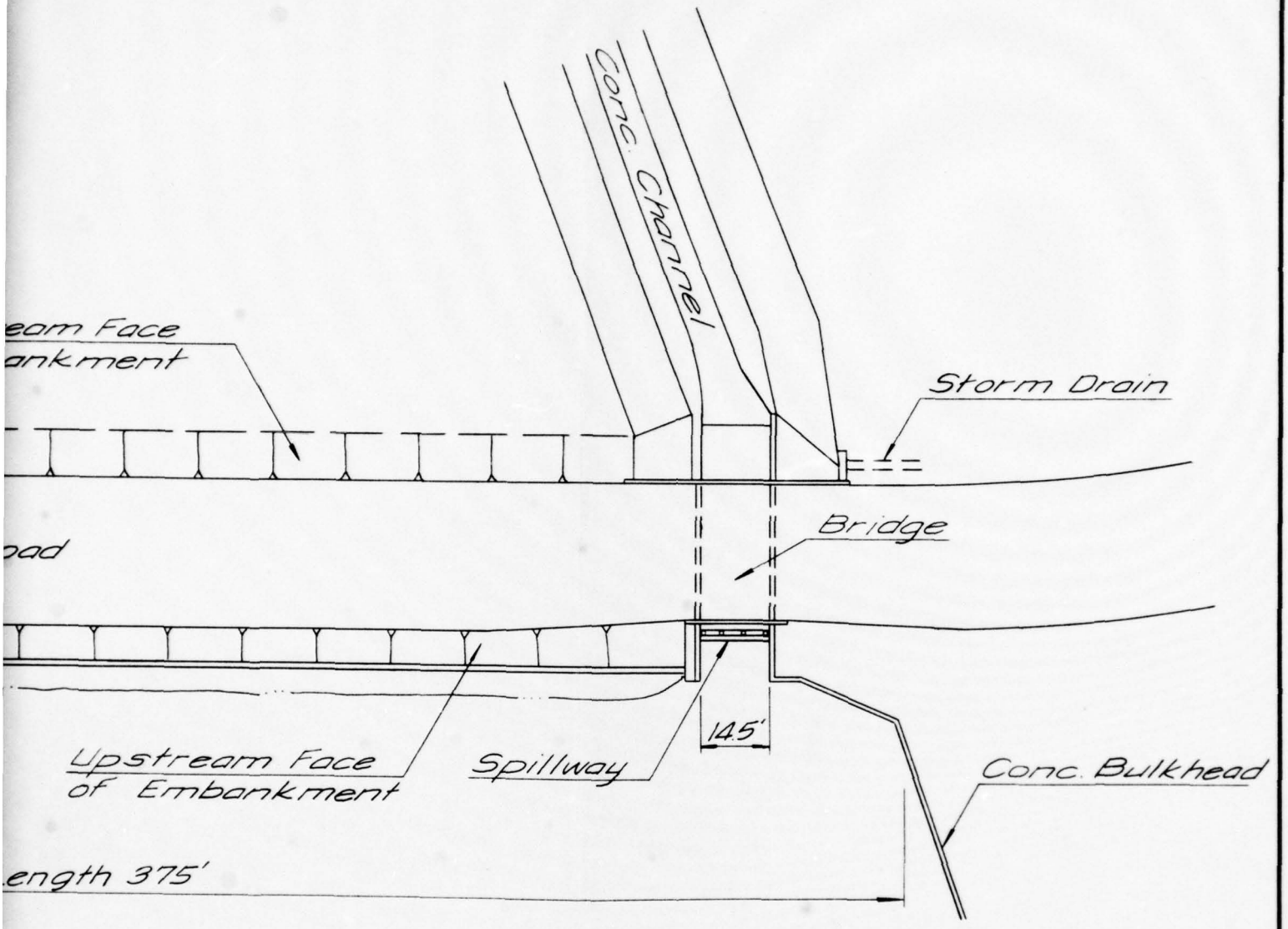


PLATE 4

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

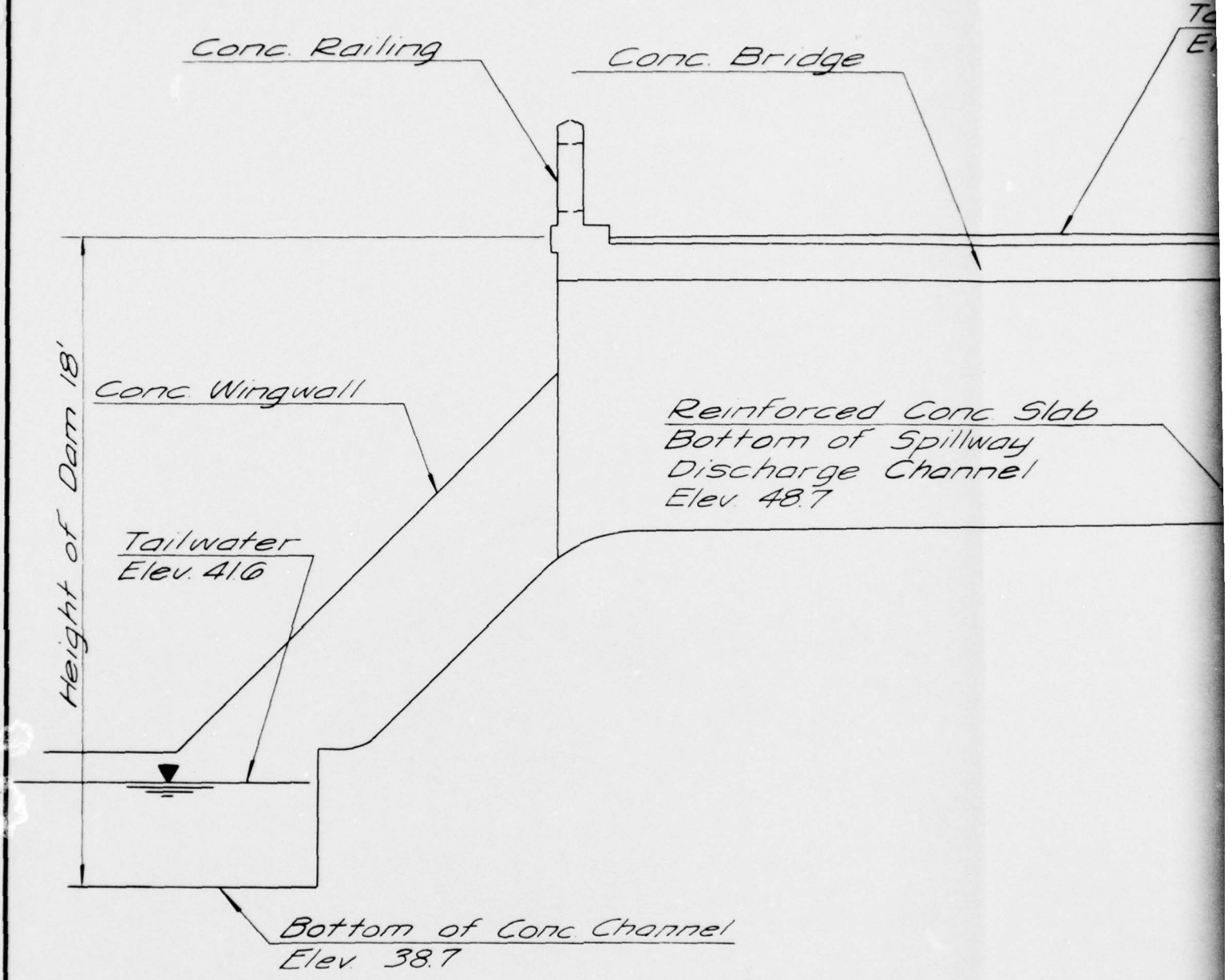
INSPECTION AND EVALUATION OF DAMS

GENERAL PLAN

CLEMENTON LAKE DAM

I.D. N.J. 00410	SCALE: NOT TO SCALE
	DATE: MARCH, 1979

2



NOTES:

1. Information taken from drawing prepared by S Herbert Taylor, Camden County Engineer, dated December 1938 and field inspection December 18, 1978.
2. Elevations refer to N.G.V.D.

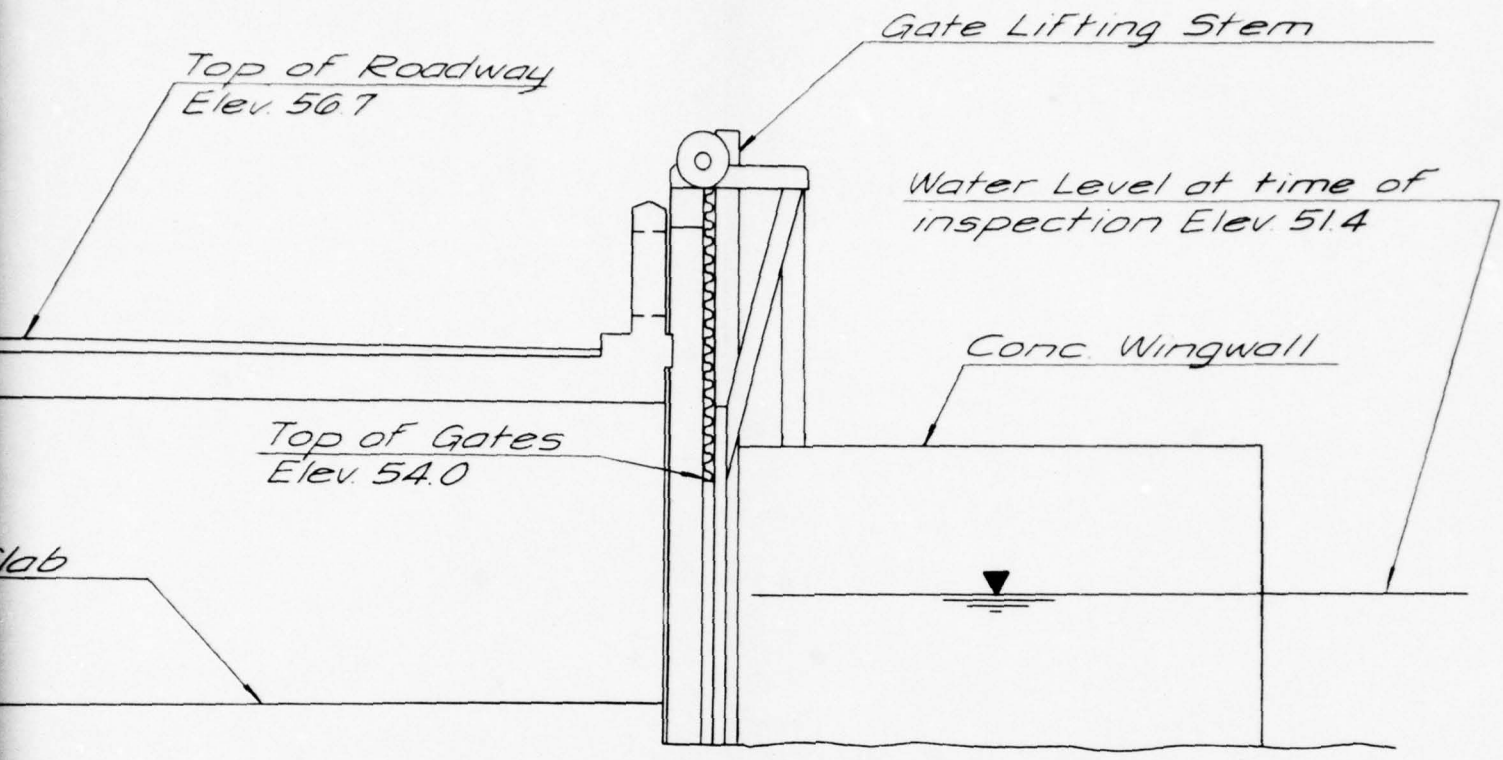
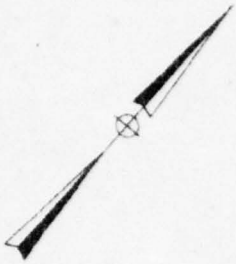


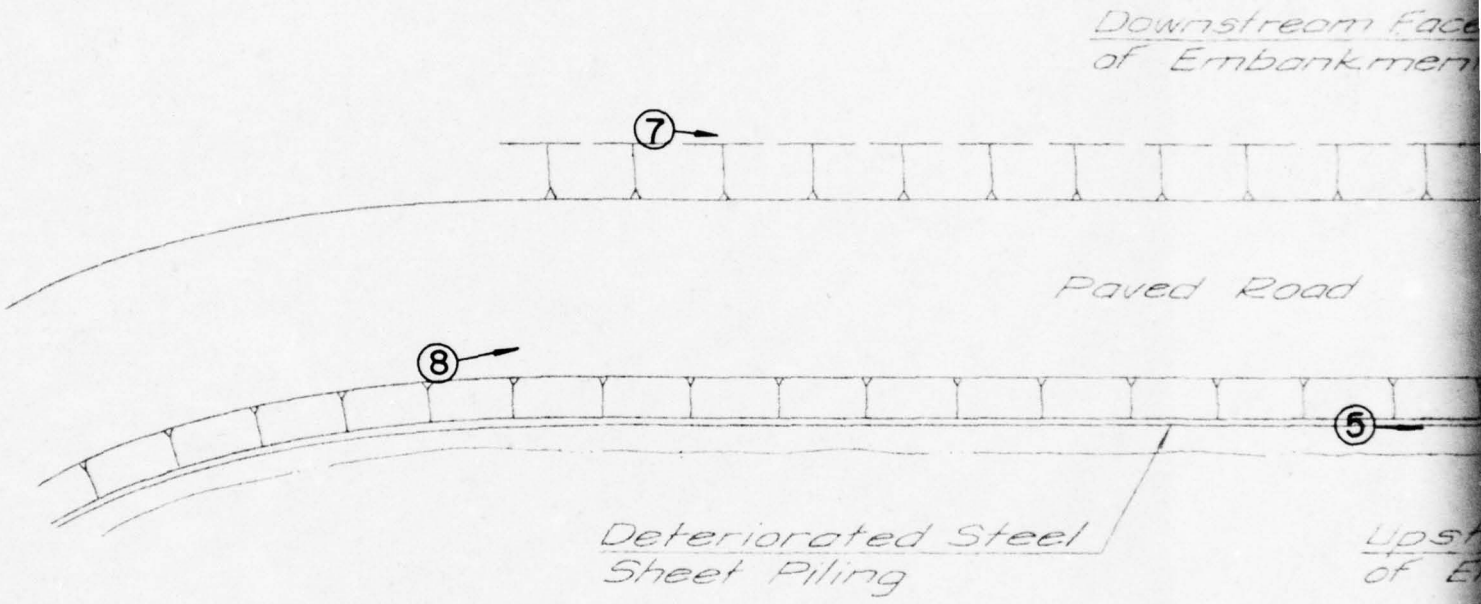
PLATE 5

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY
INSPECTION AND EVALUATION OF DAMS **SPILLWAY SECTION** CLEMENTON LAKE DAM	
I.D. N.J. 00410	SCALE: NOT TO SCALE
	DATE: MARCH, 1979

er,

2





CLEMENTON LAKE

NOTE:
Information taken from field
inspection December 18, 1978

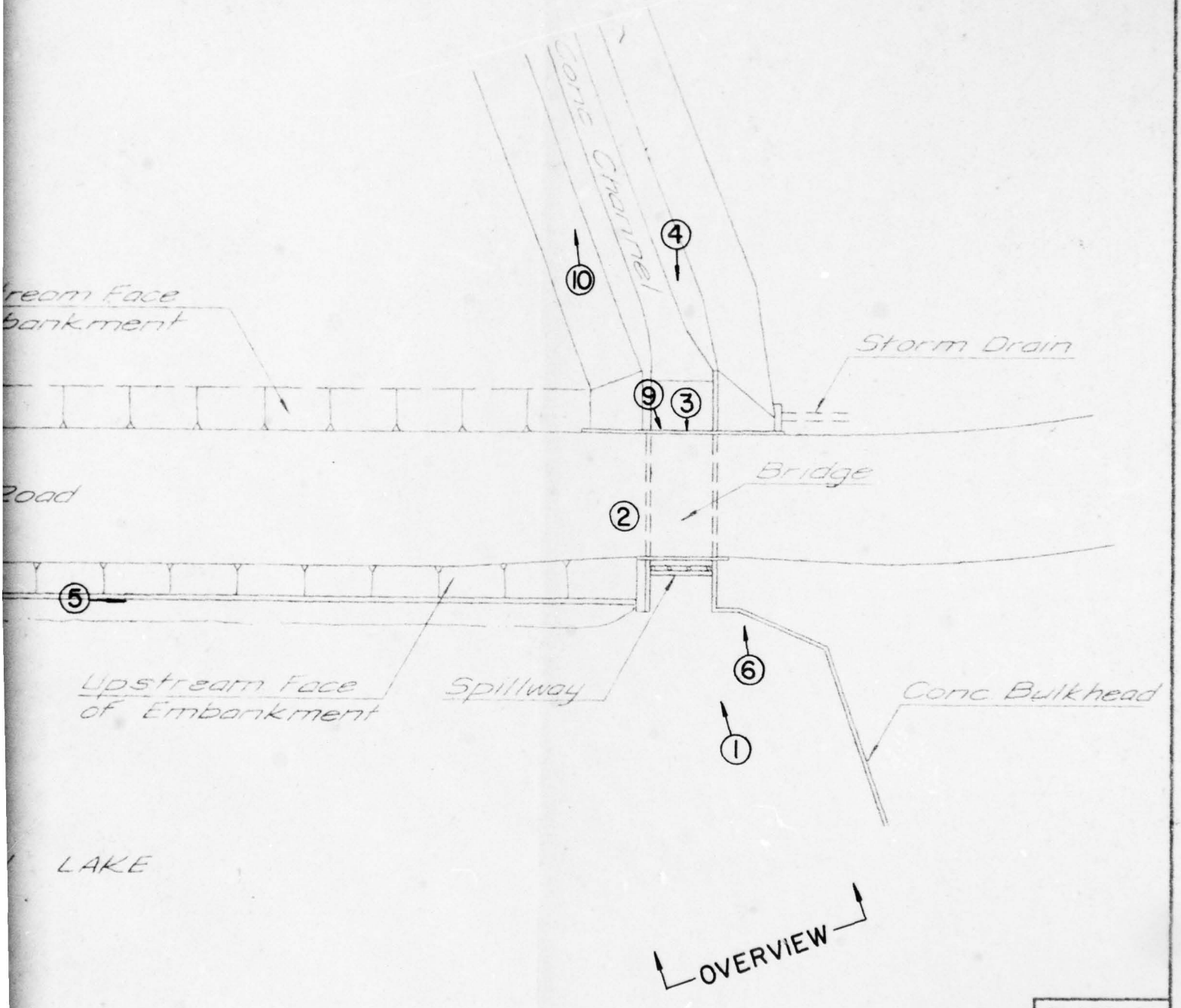


PLATE 6

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN

CLEMENTON LAKE DAM

I.D. N.J. 00410	SCALE: NOT TO SCALE
	DATE: MARCH, 1979

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List
Visual Inspection
Phase 1

Name Dam Clementon Lake County Camden State N.J. Coordinators NJDEP

Date(s) Inspection 12/18/78 Weather Sunny Temperature 40°F

Pool Elevation at Time of Inspection 51.4 M.S.L. Tailwater at Time of Inspection 41.6 M.S.L.

Inspection Personnel:

R. McDermott A. Miller

J. Gribbin

D. Buckelew

J.Gribbin Recorder

Present: Murray Baker (Owner)
George Ellenbark

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE	N.A.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N.A.	
DRAINS	N.A.	
WATER PASSAGES	N.A.	
FOUNDATION	N.A.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N.A.	
STRUCTURAL CRACKING	N.A.	
VERTICAL AND HORIZONTAL ALIGNMENT	N.A.	
MONOLITH JOINTS	N.A.	
CONSTRUCTION JOINTS	N.A.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion of upstream face. Bituminous roadway on crest of dam cracked on upstream side. Top of steel sheet piles along upstream face completely deteriorated.	Positive road drainage should be provided and the upstream slope should be protected against wave action.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Horiz. - generally straight Vert. - level No localized depressions	
RIPRAP FAILURES	N.A.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	The embankment is generally sandy with sparse grass and weeds on upstream and downstream faces. A few small trees are located on the downstream face.	Trees should be removed.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Small gap, 6" long, 1" wide, in stone wall on downstream face adjacent to north bridge abutment.	Opening should be investigated for void behind wall and repaired.
ANY NOTICEABLE SEEPAGE	None	
STAFF GAGE AND RECORDER	None	
DRAINS	One drain on each side of spillway with outlet adjacent to spillway discharge channel. Water flowing (approx. 2cfs) from north drain at time of inspection.	South drain connected to inlet in crest road. Source of south drain uncertain.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Spalling of abutments of bridge.(See Bridge and Piers) Timbers within concrete and planks on inside of conduit deteriorated.	Repair spalling and replace deteriorated timber.
INTAKE STRUCTURE	Same as Outlet Structure	
OUTLET STRUCTURE	Three timber gates. Gates and timber structure supporting gates in satisfactory condition.	Upper section of one gate open at time of inspection.
OUTLET CHANNEL	Water outflows through dam facility between concrete bridge abutments. Same as spillway discharge channel.	
EMERGENCY GATE	Timber gates same as Outlet Structure.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	N.A.	
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	N.A.	
BRIDGE AND PIERS	N.A.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N.A.	
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	No obstructions.	Straight channel through dam formed by concrete bridge abutments. Then concrete trapezoidal channel for a distance of 300' from spillway.
BRIDGE AND PIERS	Concrete bridge spanning discharge channel. Appears to be structurally sound. Concrete in wingwalls spalled. Timbers in abutments deteriorated.	
GATES AND OPERATION EQUIPMENT	See Outlet Works	Gates serve as both spillway and outlet works.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	N.A.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slopes range from 2% to 12%.	Lake level lowered approx. 2 1/2' at time of inspection.
SEDIMENTATION	Not known.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Concrete trapezoidal channel for 300' downstream of dam. No obstructions.	Road bridge 300' from dam.
SLOPES	Concrete side slopes of channel 2.3:1.	
APPROXIMATE NO. OF HOMES AND POPULATION	Urban center of Clementon 300' downstream of dam.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Not Available
REGIONAL VICINITY MAP	USGS quadrangle, "Clementon"
CONSTRUCTION HISTORY	Not Available
TYPICAL SECTIONS OF DAM	Not Available
HYDROLOGIC/HYDRAULIC DATA	Not Available
OUTLETS - PLAN	
- DETAILS	Not Available
-CONSTRAINTS -DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	Not Available

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not Available
POST-CONSTRUCTION SURVEYS OF DAM	Inspection and Report, N.J. Bureau of Water Control, May 1, 1974. Upstream dam slope eroded and wingwall deteriorated. Repairs required.
BORROW SOURCES	Unknown

ITEM	REMARKS
MONITORING SYSTEMS	Not Available
MODIFICATIONS	Not Available
HIGH POOL RECORDS	Not Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not Available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	1925 - Slide gates damaged, due to flood caused by failure of an upstream dam. 1940 - Dam overtopped, but not damaged, due to flood caused by failure of upstream dams.
MAINTENANCE OPERATION RECORDS	Not Available

ITEM	REMARKS
SPILLWAY PLAN	Not Available
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Not Available

APPENDIX 2

Photographs

PHOTO 1

UPSTREAM VIEW OF SPILLWAY

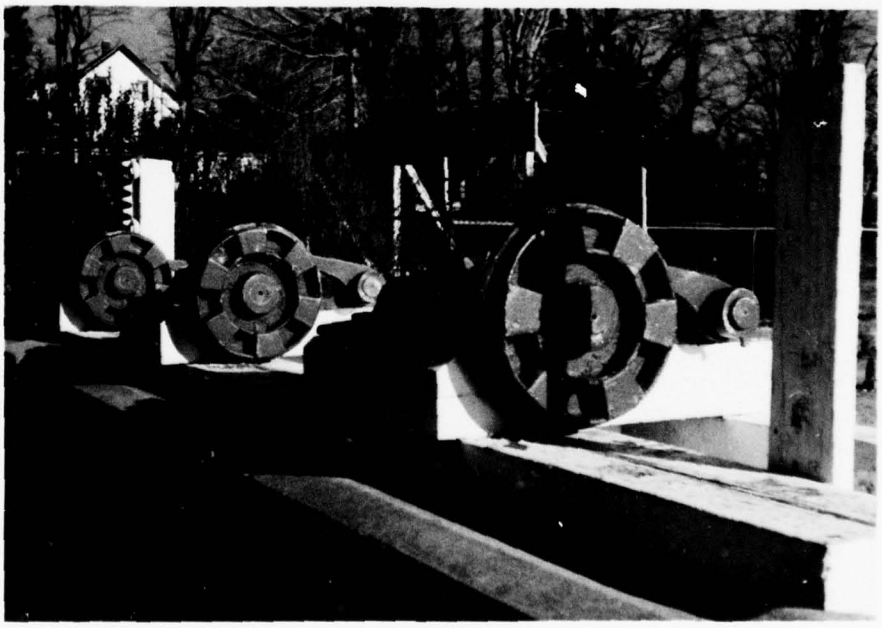


PHOTO 2

SPILLWAY GATE OPERATING MECHANISM

18 Dec 1978

PHOTO 3

SPILLWAY DISCHARGE CHANNEL THROUGH DAM
FORMED BY BRIDGE ABUTMENTS

PHOTO 4

SPILLOVER AT DOWNSTREAM END OF SPILLWAY
DISCHARGE CHANNEL

18 Dec 1978

PHOTO 5

UPSTREAM FACE OF EMBANKMENT
DETERIORATED STEEL SHEET PILING

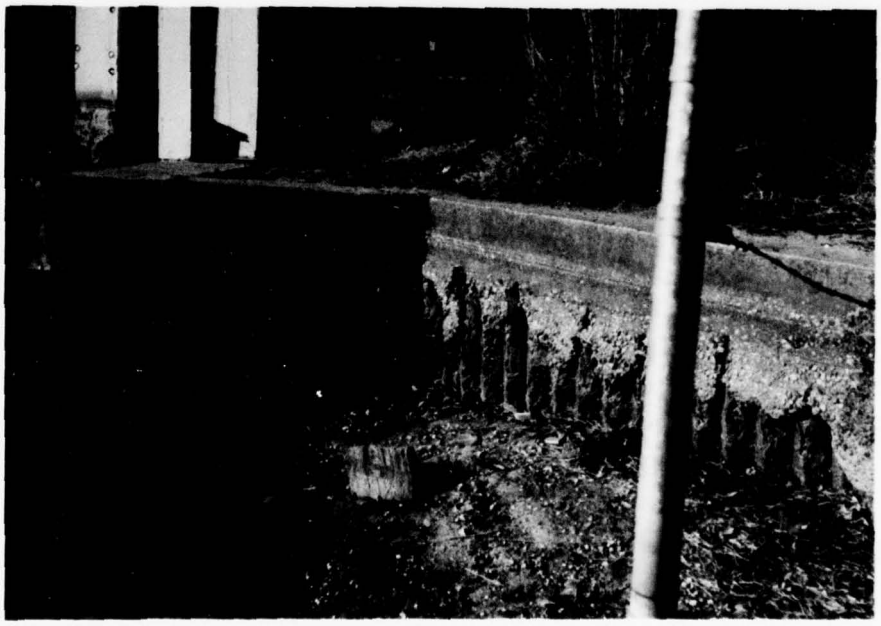


PHOTO 6

DETERIORATED STEEL SHEET PILING AND
CONCRETE ADJACENT TO SPILLWAY

18 Dec. 1978

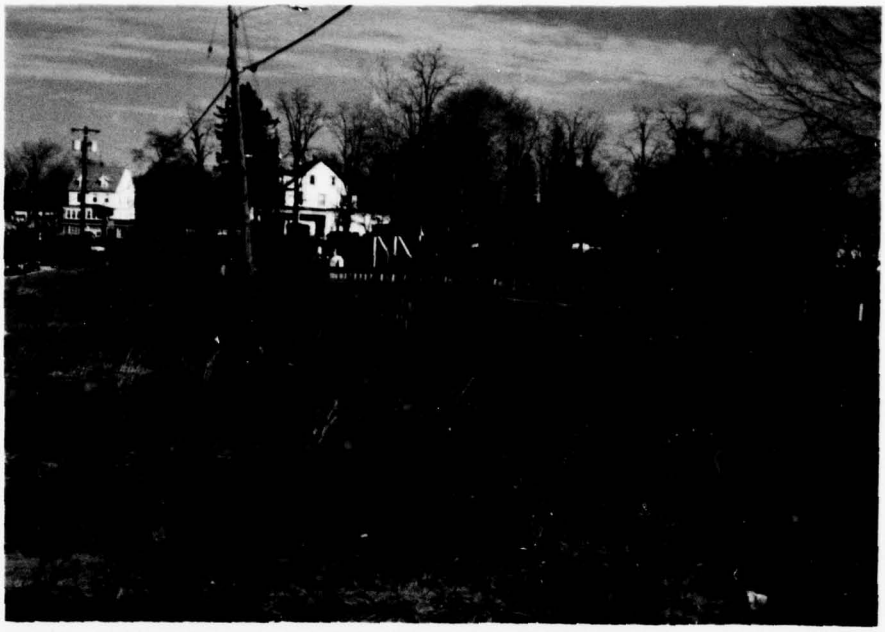


PHOTO 7

DOWNSTREAM FACE OF EMBANKMENT

PHOTO 8

PAVED ROAD ON CREST OF DAM

18 Dec. 1978

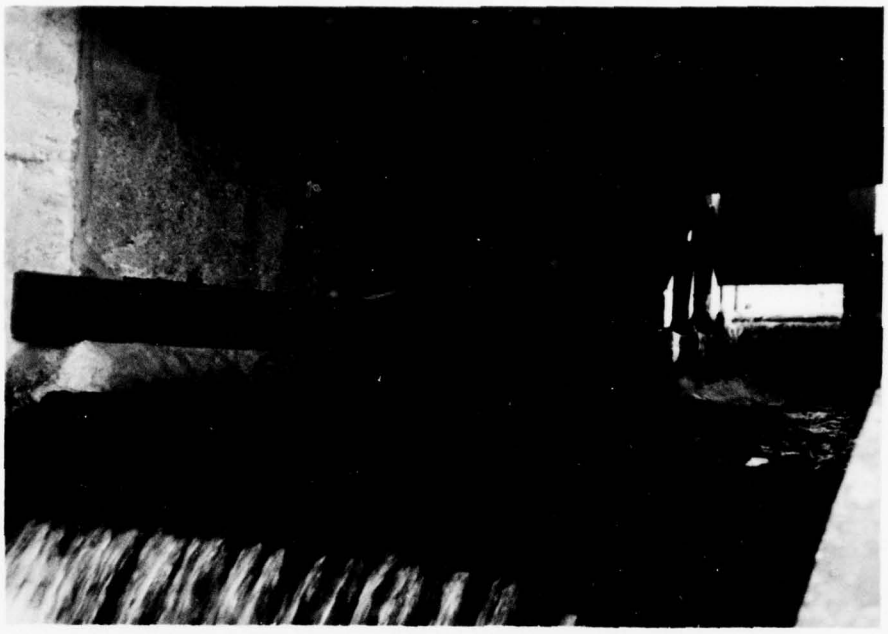


PHOTO 9

DETERIORATED TIMBERS IN SPILLWAY DISCHARGE CHANNEL

PHOTO 10

DOWNSTREAM CHANNEL

18 Dec. 1978

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 2.8 square miles
Sparsely developed, one upstream lake.
Cranberry bogs and woodland.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 54.0 MSL (28 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 58.8

ELEVATION TOP DAM: 56.7

SPILLWAY CREST: Top of Timber Slide Gates

- **a. Elevation** 54.0 (top of gates)
- **b. Type** Sharp-crested weirs
- **c. Width** Approx. 3 inches
- **d. Length** 12.8 feet (total), approx. 4.3 feet each
- **e. Location Spillover** Downstream face of timber slide gates
- **f. Number and Type of Gates** 3 manual timber slide gates

OUTLET WORKS: 3 timber slide gates

- **a. Type** Timber slide gates
- **b. Location** Spillway
- **c. Entrance inverts** 51.0
- **d. Exit inverts** 48.7
- **e. Emergency draindown facilities:** Slide gates

HYDROMETEOROLOGICAL GAGES: None

- **a. Type** N.A.
- **b. Location** N.A.
- **c. Records** N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake stage equal to top of dam) 163 cfs

APPENDIX 4

Hydrologic Computations

STORCH ENGINEERS Sheet 1 of 10

Project Clementon Lake Dam Made By RL Date 3-22-79

1132 Chkd By DMP Date 3-26-79

Size classification

Volume of impoundment at top of dam	79 Ac-ft.
Height of dam	18 ft.
Size classification	Small

Hazard Potential Classification

Number of inhabitable structures	Approx 6
Hazard potential classification	High
Recommended SDF	½ PMF

Hydrologic Analysis

The runoff hydrograph will be developed by HEC-1-DB using the SCS triangular UHG with curvelinear transformation and routing by Modified Puls method.

Drainage Area = 2.8 Sq. mi.

Infiltration Data

Watershed area consists of both urban and wooded areas use initial abstraction 1 in and 0.1 in/hr.

Time of concentration

Length of channel = 13200' = 2.5 mi

Slope of channel = $\frac{150-54}{13200}$ = 7%

Vel. of travel from SCS TR-55 = 1.3 ft/sec

$$Tc = \frac{13200}{1.3 \times 3600} = 2.82 \text{ hr}$$

Alternate method

Use SCS nomograph
L = 13200 ft.
H = 96'

See Pg 71 "Design of small Dams"

Tc = 1.25 hr. x 1.6 (adjustment factor)
= 2 hr.

Use Tc = 2.2 hrs.

T_{Lag} = 0.6 x 2.2 hrs
= 1.32 hr

Lake Storage Volume

Information from USGS map

EL(ft)	48.7	54	60	70
Surface area Ac.	0	16	30	119

STORCH ENGINEERS

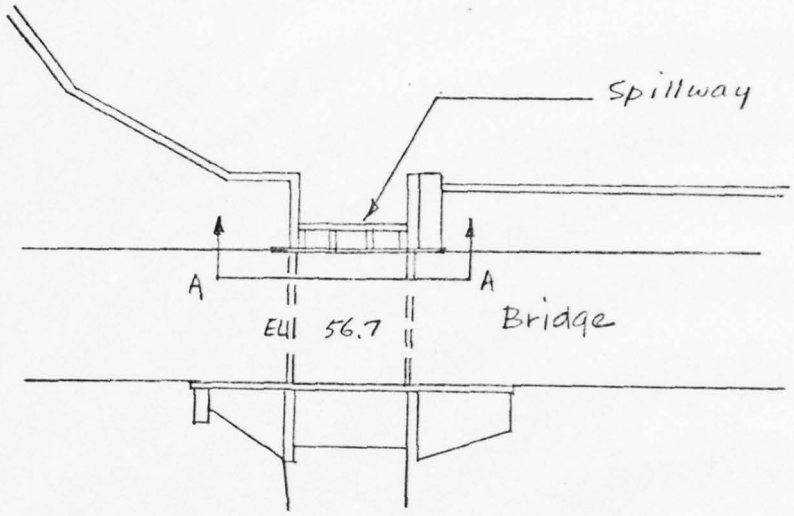
Sheet 4 of 10

Project Clementon Lake Dam 1132

Made By RL Date 3-23-7

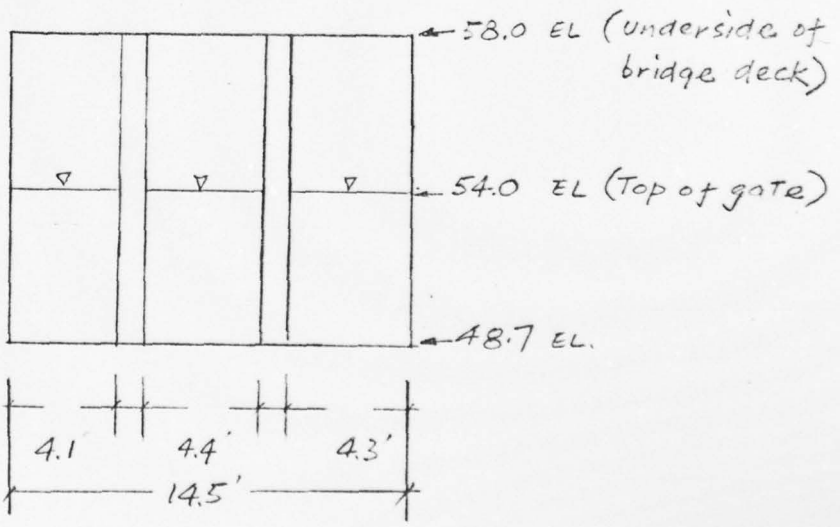
Chkd By DMP Date 3-26-7

SPILLWAY



Length of Dam 375' @ EL 56.7

Total overtopping length = 575' @ EL 56.7



SECTION A A

STAGE DISCHARGE TABULATION

Ref. Pg 373 "Design of Small Dam"

Total length of spillway 14.5 ft.

Discharge will be calculated by using :

$Q = CL H^{3/2}$

$L = L' - 2(N Kp + Ka) H$

Where L = effective length of crest
L' = net length of crest
N = number of piers
Kp = pier contraction coef.
Ka = abutment contraction coef.
H = total head

$N = 2$
$Kp = 0.02$
$Ka = 0.2$
$L' = 12.8'$

$L = 12.8' - 2(2 \times 0.02 + 0.2) H$

$L = 12.8' - 0.48 H$

For WL above el. 56', The spillway will act as an orifice $Q = CA\sqrt{2gh}$ $C = 0.6$

$A = 2 \times 12.8 = 25.6$ S.F

STAGE DISCHARGE TABULATION of Spillway

W.L. (ft)	H (ft)	C	L (ft)	$H^{3/2}$	$Q = CLH^{3/2}$ (cfs)
54.0	0	3.3	-	-	0
54.5	0.5	3.3	12.5	0.35	15
55.0	1.0	3.3	12.3	1	41
55.5	1.5	3.3	12.1	1.84	74
56.0	2.0	3.3	11.8	2.83	110
At this point, discharge changes from weir flow to orifice flow. $Q = CA\sqrt{2gh}$ (h = W.L. to mid-pt. of opening)					
56.5	1.5	0.6	-	-	151
57.0	2.0	0.6	-	-	174
57.5	2.5	0.6	-	-	195
58.0	3.0	0.6	-	-	214
60.0	5.0	0.6	-	-	276

STORCH ENGINEERS

Sheet 7 of 10

Project Clementon Lake Dam

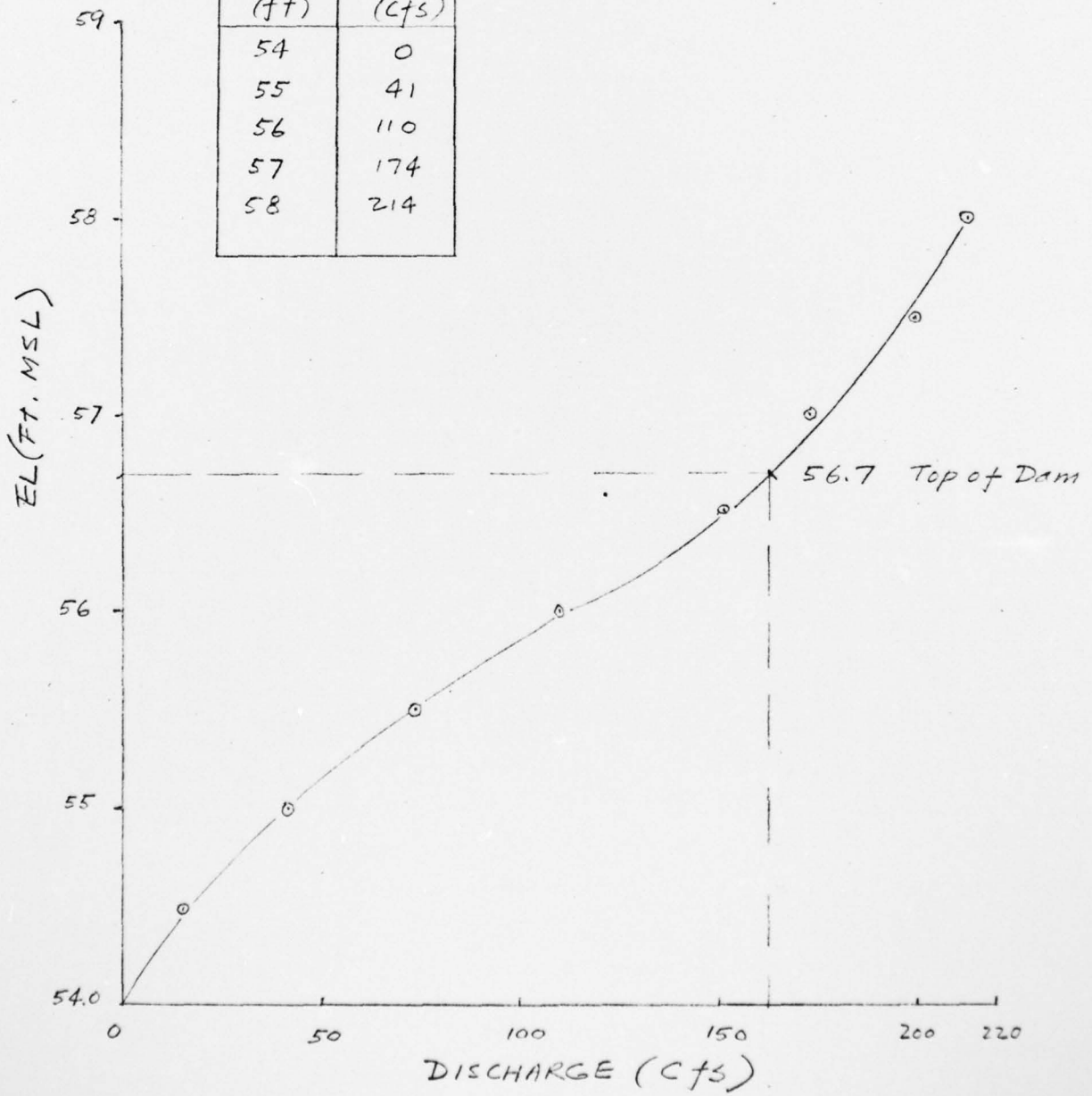
Made By RL Date 3-26-79

Chkd By DMF Date 3-26-79

STAGE DISCHARGE CURVE

For spillway only

W.L. (ft)	Q (cfs)
54	0
55	41
56	110
57	174
58	214



Capacity of Outlet Works

Assume drawdown by openning 1 gate half way (to avoid overflowing normal downstream channel)

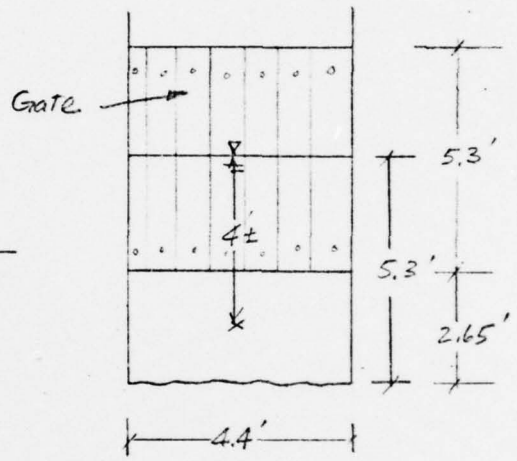
$$A = 4.4 \times \left(\frac{54 - 48.7}{2}\right)$$

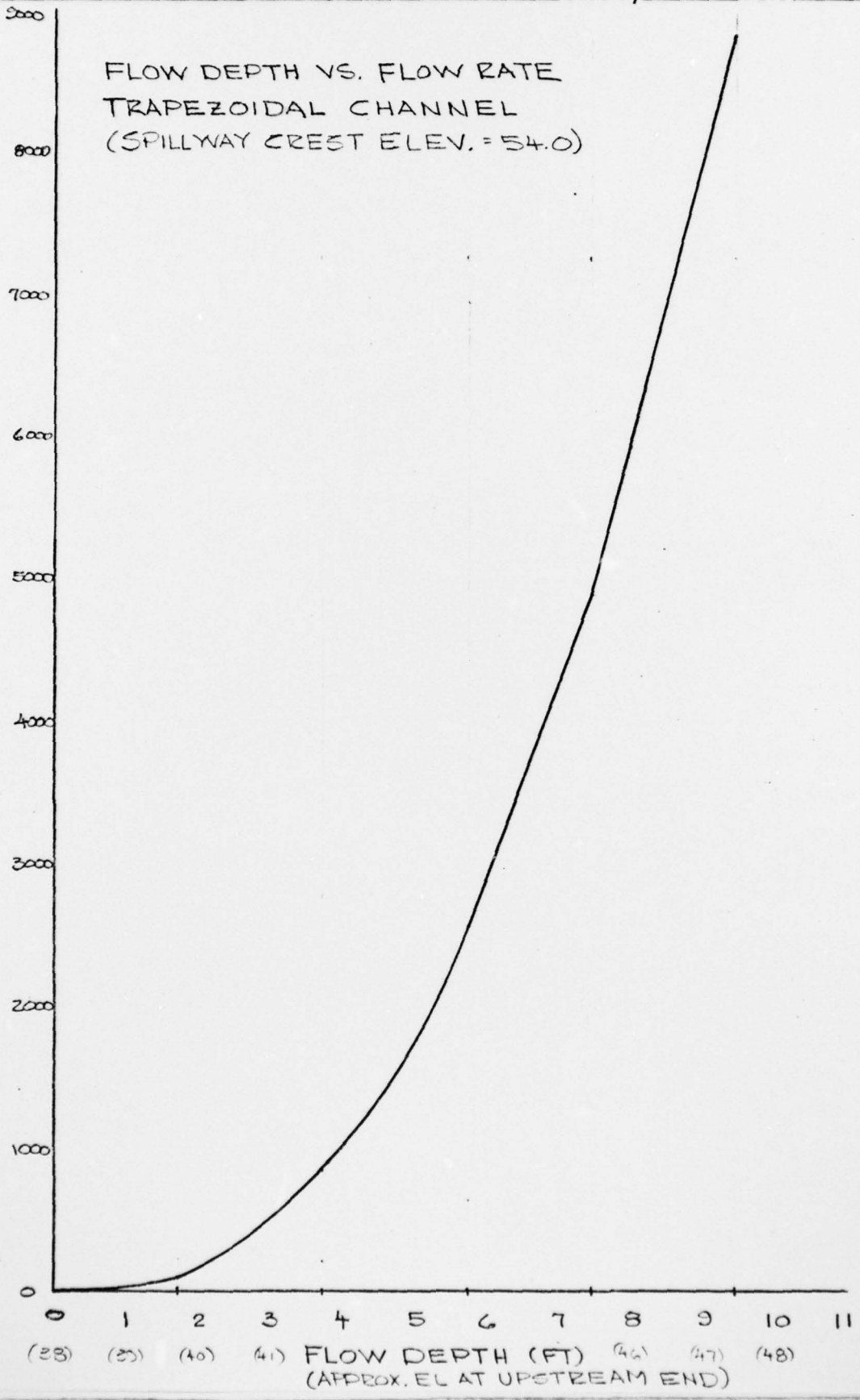
$$= 11.66 \text{ S.F.}$$

$$Q = CA\sqrt{2gh}$$

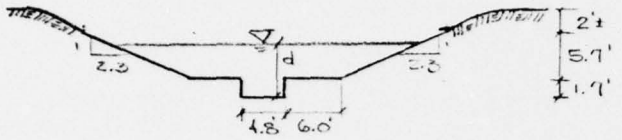
$$= 0.6 \times 11.66 \times \sqrt{2g \times 4}$$

$$= \underline{\underline{112}} \text{ c/s}$$




FLOW DEPTH VS. FLOW RATE
TRAPEZOIDAL CHANNEL
(SPILLWAY CREST ELEV. = 54.0)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0 1 2 3 4 5 6 7 8 9 10 11
(38) (39) (40) (41) FLOW DEPTH (FT) (46) (47) (48)
(APPROX. EL AT UPSTREAM END)

TRAPEZOIDAL CONCRETE CHANNEL -



-Typical Channel Section-

d = flow depth
s = approx. channel slope = 1%
n = 0.013

Use 5 step to compute a stage/flow rate curve for the downstream channel.

Based on a preliminary evaluation the Road Bridge Culverts and channl reaches downstream of the trapezoidal channel, the trapezoidal channel will control flow in the area immediately downstream from the dam.

Step	d (ft)	A (ft²)	WP (ft)	R (ft)	V (fps)	Q (cfs)
1	1.7	8.16	8.20	0.995	11.42	93.21
2	3.7	50.96	30.23	1.686	16.24	827.53
3	5.7	112.16	40.26	2.786	22.70	2546.15
4	7.4	178.65	48.79	3.662	27.24	4866.83
5	9.4	273.80	58.82	4.656	31.98	8757.72

HEC-1-DB COMPUTATIONS

```
A1                    NATIONAL DAM SAFETY PROGRAM
A2                CLEMENTON LAKE DAM NEW JERSEY
A3                          MULTI RATIO ROUTING
B     200         0        15                                0        0        3
B1      5
J       1         5         1
J1    0.5       0.4       0.3       0.2       0.1
K       0      CLEM                   0         0         1
K1                SUBAREA RUNOFF TO CLEMENTON LAKE
M       1         2       2.8                   0                             1
P       0        27       100       109       117
T                                                       1.0       0.1
W2              1.32
X     -1.0     -0.05       2.0
K       1       DAM                    0         0         1
K1                ROUTE DISCHARGE THROUGH CLEMENTON LAKE DAM
Y                                  1         1
Y1      1                                                -54       -1
Y4     54      54.5        55      55.5        56      56.5        57      57.5        58        60
Y5      0        15        41        74       110       151       174       199       214       276
SA      0        16        30       119
SE   48.7        54        60        70
SS     54
SD   56.7      2.63       1.5       575
K      99
A
A
A
A
A
```

(2)

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 79/04/11.
     TIME= 08.54.12.
```

NATIONAL DAM SAFETY PROGRAM
CLEMENTON LAKE DAM NEW JERSEY
MULTI RATIO ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
200	0	15	0	0	0	0	0	3	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1

RTIOS= .50 .40 .30 .20 .10

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

SUBAREA RUNOFF TO CLEMENTON LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
CLEM	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	2.80	0.00	2.80	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	27.00	100.00	109.00	117.00	0.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.10	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 1.32

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 28 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.32 VOL= 1.00

76.	230.	474.	756.	907.	932.	863.	742.	572.	411.
307.	236.	180.	133.	101.	77.	58.	43.	33.	25.
19.	14.	11.	9.	7.	5.	3.	1.		

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q
1.01	.15	1	.03	0.00	.03	3.
1.01	.30	2	.03	0.00	.03	2.
1.01	.45	3	.03	0.00	.03	2.
1.01	1.00	4	.03	0.00	.03	2.
1.01	1.15	5	.03	0.00	.03	2.
1.01	1.30	6	.03	0.00	.03	2.
1.01	1.45	7	.03	0.00	.03	2.
1.01	2.00	8	.03	0.00	.03	2.
1.01	2.15	9	.03	0.00	.03	2.
1.01	2.30	10	.03	0.00	.03	1.
1.01	2.45	11	.03	0.00	.03	1.
1.01	3.00	12	.03	0.00	.03	1.
1.01	3.15	13	.03	0.00	.03	1.
1.01	3.30	14	.03	0.00	.03	1.
1.01	3.45	15	.03	0.00	.03	1.
1.01	4.00	16	.03	0.00	.03	1.
1.01	4.15	17	.03	0.00	.03	1.
1.01	4.30	18	.03	0.00	.03	1.
1.01	4.45	19	.03	0.00	.03	1.
1.01	5.00	20	.03	0.00	.03	1.
1.01	5.15	21	.03	0.00	.03	1.
1.01	5.30	22	.03	0.00	.03	1.
1.01	5.45	23	.03	0.00	.03	1.
1.01	6.00	24	.03	0.00	.03	1.
1.01	6.15	25	.08	0.00	.08	0.
1.01	6.30	26	.08	0.00	.08	0.
1.01	6.45	27	.08	0.00	.08	0.
1.01	7.00	28	.08	.01	.07	1.
1.01	7.15	29	.08	.06	.03	7.
1.01	7.30	30	.08	.06	.03	22.
1.01	7.45	31	.08	.06	.03	52.
1.01	8.00	32	.08	.06	.03	96.
1.01	8.15	33	.08	.06	.03	147.
1.01	8.30	34	.08	.06	.03	198.
1.01	8.45	35	.08	.06	.03	245.
1.01	9.00	36	.08	.06	.03	285.
1.01	9.15	37	.08	.06	.03	315.
1.01	9.30	38	.08	.06	.03	337.
1.01	9.45	39	.08	.06	.03	354.
1.01	10.00	40	.08	.06	.03	366.
1.01	10.15	41	.08	.06	.03	376.
1.01	10.30	42	.08	.06	.03	383.
1.01	10.45	43	.08	.06	.03	389.
1.01	11.00	44	.08	.06	.03	393.
1.01	11.15	45	.08	.06	.03	396.
1.01	11.30	46	.08	.06	.03	398.
1.01	11.45	47	.08	.06	.03	400.
1.01	12.00	48	.08	.06	.03	401.
1.01	12.15	49	.54	.51	.03	437.
1.01	12.30	50	.54	.51	.03	543.
1.01	12.45	51	.54	.51	.03	761.
1.01	13.00	52	.54	.51	.03	1108.
1.01	13.15	53	.65	.62	.03	1533.
1.01	13.30	54	.65	.62	.03	1986.
1.01	13.45	55	.65	.62	.03	2434.
1.01	14.00	56	.65	.62	.03	2856.
1.01	14.15	57	.81	.78	.03	3229.
1.01	14.30	58	.81	.78	.03	3555.
1.01	14.45	59	.81	.78	.03	3867.
1.01	15.00	60	.81	.78	.03	4177.
1.01	15.15	61	.82	.80	.03	4470.
1.01	15.30	62	1.64	1.62	.03	4791.
1.01	15.45	63	4.60	4.57	.03	5428.
1.01	16.00	64	1.15	1.12	.03	6423.
1.01	16.15	65	.76	.73	.03	7770.
1.01	16.30	66	.76	.73	.03	9135.
1.01	16.45	67	.76	.73	.03	9874.
1.01	17.00	68	.76	.73	.03	9980.
1.01	17.15	69	.59	.57	.03	9607.
1.01	17.30	70	.59	.57	.03	8927.
1.01	17.45	71	.59	.57	.03	8009.
1.01	18.00	72	.59	.57	.03	7110.
1.02	1.15	101	0.00	0.00	0.00	166.
1.02	1.30	102	0.00	0.00	0.00	155.
1.02	1.45	103	0.00	0.00	0.00	145.
1.02	2.00	104	0.00	0.00	0.00	135.
1.02	2.15	105	0.00	0.00	0.00	126.
1.02	2.30	106	0.00	0.00	0.00	117.
1.02	2.45	107	0.00	0.00	0.00	110.
1.02	3.00	108	0.00	0.00	0.00	102.
1.02	3.15	109	0.00	0.00	0.00	95.
1.02	3.30	110	0.00	0.00	0.00	89.
1.02	3.45	111	0.00	0.00	0.00	83.
1.02	4.00	112	0.00	0.00	0.00	77.
1.02	4.15	113	0.00	0.00	0.00	72.
1.02	4.30	114	0.00	0.00	0.00	67.
1.02	4.45	115	0.00	0.00	0.00	63.
1.02	5.00	116	0.00	0.00	0.00	59.
1.02	5.15	117	0.00	0.00	0.00	55.
1.02	5.30	118	0.00	0.00	0.00	51.
1.02	5.45	119	0.00	0.00	0.00	48.
1.02	6.00	120	0.00	0.00	0.00	44.
1.02	6.15	121	0.00	0.00	0.00	42.
1.02	6.30	122	0.00	0.00	0.00	39.
1.02	6.45	123	0.00	0.00	0.00	36.
1.02	7.00	124	0.00	0.00	0.00	34.
1.02	7.15	125	0.00	0.00	0.00	31.
1.02	7.30	126	0.00	0.00	0.00	29.
1.02	7.45	127	0.00	0.00	0.00	27.
1.02	8.00	128	0.00	0.00	0.00	26.
1.02	8.15	129	0.00	0.00	0.00	24.
1.02	8.30	130	0.00	0.00	0.00	22.
1.02	8.45	131	0.00	0.00	0.00	21.
1.02	9.00	132	0.00	0.00	0.00	19.
1.02	9.15	133	0.00	0.00	0.00	18.
1.02	9.30	134	0.00	0.00	0.00	17.
1.02	9.45	135	0.00	0.00	0.00	16.
1.02	10.00	136	0.00	0.00	0.00	15.
1.02	10.15	137	0.00	0.00	0.00	14.
1.02	10.30	138	0.00	0.00	0.00	13.
1.02	10.45	139	0.00	0.00	0.00	12.
1.02	11.00	140	0.00	0.00	0.00	11.
1.02	11.15	141	0.00	0.00	0.00	10.
1.02	11.30	142	0.00	0.00	0.00	10.
1.02	11.45	143	0.00	0.00	0.00	9.
1.02	12.00	144	0.00	0.00	0.00	8.
1.02	12.15	145	0.00	0.00	0.00	8.
1.02	12.30	146	0.00	0.00	0.00	7.
1.02	12.45	147	0.00	0.00	0.00	7.
1.02	13.00	148	0.00	0.00	0.00	6.
1.02	13.15	149	0.00	0.00	0.00	6.
1.02	13.30	150	0.00	0.00	0.00	6.
1.02	13.45	151	0.00	0.00	0.00	5.
1.02	14.00	152	0.00	0.00	0.00	5.
1.02	14.15	153	0.00	0.00	0.00	5.
1.02	14.30	154	0.00	0.00	0.00	4.
1.02	14.45	155	0.00	0.00	0.00	4.
1.02	15.00	156	0.00	0.00	0.00	4.
1.02	15.15	157	0.00	0.00	0.00	3.
1.02	15.30	158	0.00	0.00	0.00	3.
1.02	15.45	159	0.00	0.00	0.00	3.
1.02	16.00	160	0.00	0.00	0.00	3.
1.02	16.15	161	0.00	0.00	0.00	3.
1.02	16.30	162	0.00	0.00	0.00	2.
1.02	16.45	163	0.00	0.00	0.00	2.
1.02	17.00	164	0.00	0.00	0.00	2.
1.02	17.15	165	0.00	0.00	0.00	2.
1.02	17.30	166	0.00	0.00	0.00	2.
1.02	17.45	167	0.00	0.00	0.00	2.
1.02	18.00	168	0.00	0.00	0.00	2.
1.02	18.15	169	0.00	0.00	0.00	1.
1.02	18.30	170	0.00	0.00	0.00	1.
1.02	18.45	171	0.00	0.00	0.00	1.
1.02	19.00	172	0.00	0.00	0.00	1.

1.01	18.15	73	.04	.02	.03	6398.	1.02	19.15	173	0.00	0.00	0.00		1.
1.01	18.30	74	.04	.02	.03	5757.	1.02	19.30	174	0.00	0.00	0.00		1.
1.01	18.45	75	.04	.02	.03	5072.	1.02	19.45	175	0.00	0.00	0.00		1.
1.01	19.00	76	.04	.02	.03	4306.	1.02	20.00	176	0.00	0.00	0.00		1.
1.01	19.15	77	.04	.02	.03	3549.	1.02	20.15	177	0.00	0.00	0.00		1.
1.01	19.30	78	.04	.02	.03	2844.	1.02	20.30	178	0.00	0.00	0.00		1.
1.01	19.45	79	.04	.02	.03	2223.	1.02	20.45	179	0.00	0.00	0.00		1.
1.01	20.00	80	.04	.02	.03	1705.	1.02	21.00	180	0.00	0.00	0.00		1.
1.01	20.15	81	.04	.02	.03	1308.	1.02	21.15	181	0.00	0.00	0.00		1.
1.01	20.30	82	.04	.02	.03	1019.	1.02	21.30	182	0.00	0.00	0.00		1.
1.01	20.45	83	.04	.02	.03	802.	1.02	21.45	183	0.00	0.00	0.00		1.
1.01	21.00	84	.04	.02	.03	635.	1.02	22.00	184	0.00	0.00	0.00		1.
1.01	21.15	85	.04	.02	.03	510.	1.02	22.15	185	0.00	0.00	0.00		0.
1.01	21.30	86	.04	.02	.03	470.	1.02	22.30	186	0.00	0.00	0.00		0.
1.01	21.45	87	.04	.02	.03	438.	1.02	22.45	187	0.00	0.00	0.00		0.
1.01	22.00	88	.04	.02	.03	409.	1.02	23.00	188	0.00	0.00	0.00		0.
1.01	22.15	89	.04	.02	.03	381.	1.02	23.15	189	0.00	0.00	0.00		0.
1.01	22.30	90	.04	.02	.03	356.	1.02	23.30	190	0.00	0.00	0.00		0.
1.01	22.45	91	.04	.02	.03	332.	1.02	23.45	191	0.00	0.00	0.00		0.
1.01	23.00	92	.04	.02	.03	310.	1.03	0.00	192	0.00	0.00	0.00		0.
1.01	23.15	93	.04	.02	.03	289.	1.03	.15	193	0.00	0.00	0.00		0.
1.01	23.30	94	.04	.02	.03	270.	1.03	.30	194	0.00	0.00	0.00		0.
1.01	23.45	95	.04	.02	.03	252.	1.03	.45	195	0.00	0.00	0.00		0.
1.02	0.00	96	.04	.02	.03	235.	1.03	1.00	196	0.00	0.00	0.00		0.
1.02	.15	97	0.00	0.00	0.00	219.	1.03	1.15	197	0.00	0.00	0.00		0.
1.02	.30	98	0.00	0.00	0.00	204.	1.03	1.30	198	0.00	0.00	0.00		0.
1.02	.45	99	0.00	0.00	0.00	191.	1.03	1.45	199	0.00	0.00	0.00		0.
1.02	1.00	100	0.00	0.00	0.00	178.	1.03	2.00	200	0.00	0.00	0.00		0.
									SUM	25.27	22.57	2.70	166741.	
										(642.)	(573.)	(69.)	(4721.58)	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9980.	5811.	1732.	834.	166743.
CMS	283.	165.	49.	24.	4722.
INCHES		19.31	23.02	23.08	23.08
MM		490.36	584.62	586.28	586.28
AC-FT		2881.	3435.	3445.	3445.
THOUS CU M		3554.	4237.	4249.	4249.

HYDROGRAPH AT STA CLEM FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4990.	2905.	866.	417.	83372.
CMS	141.	82.	25.	12.	2361.
INCHES		9.65	11.51	11.54	11.54
MM		245.18	292.31	293.14	293.14
AC-FT		1441.	1718.	1723.	1723.
THOUS CU M		1777.	2119.	2125.	2125.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE DISCHARGE THROUGH CLEMENTON LAKE DAM (0.5 PMF - DAM OVERTOPPING)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-54.	-1

STAGE	54.00	54.50	55.00	55.50	56.00	56.50	57.00	57.50	58.00	60.00
FLOW	0.00	15.00	41.00	74.00	110.00	151.00	174.00	199.00	214.00	276.00
SURFACE AREA=	0.	16.	30.	119.						
CAPACITY=	0.	28.	164.	860.						
ELEVATION=	49.	54.	60.	70.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
54.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
56.7	2.6	1.5	575.

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1.	3.	5.	8.	12.	17.	25.	33.	41.	51.
61.	70.	79.	87.	95.	103.	110.	117.	124.	134.
149.	185.	497.	816.	1077.	1308.	1513.	1693.	1855.	2012.
2165.	2320.	2565.	2986.	3592.	4289.	4806.	4982.	4887.	4603.
4193.	3738.	3345.	3016.	2688.	2329.	1955.	1599.	1279.	1002.
780.	612.	486.	391.	318.	270.	244.	227.	212.	199.
187.	177.	168.	161.	159.	157.	156.	153.	151.	147.
142.	137.	132.	127.	122.	118.	113.	108.	104.	100.
96.	92.	88.	84.	80.	76.	73.	70.	67.	64.
61.	58.	55.	52.	50.	47.	45.	43.	41.	39.
37.	36.	34.	33.	31.	30.	28.	27.	26.	25.
24.	22.	21.	20.	19.	18.	18.	17.	16.	15.
15.	14.	14.	13.	13.	13.	12.	12.	11.	11.
11.	10.	10.	10.	9.	9.	9.	8.	8.	8.
8.	7.	7.	7.	7.	6.	6.	6.	6.	6.
5.	5.	5.	5.	5.	5.	4.	4.	4.	4.
4.	4.	4.	3.	3.	3.	3.	3.	3.	3.

STORAGE

28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
28.	28.	28.	28.	28.	28.	28.	28.	28.	29.
29.	30.	31.	33.	35.	37.	40.	43.	45.	48.
51.	53.	56.	58.	60.	62.	64.	66.	68.	70.
74.	80.	87.	92.	95.	98.	100.	102.	103.	105.
107.	108.	110.	114.	120.	125.	130.	131.	130.	128.
125.	121.	117.	114.	112.	108.	104.	101.	97.	94.
91.	89.	87.	85.	84.	83.	82.	82.	81.	81.
80.	80.	80.	79.	79.	78.	77.	76.	75.	74.
72.	71.	70.	69.	67.	66.	65.	64.	63.	62.
60.	59.	58.	57.	56.	55.	54.	53.	52.	52.
51.	50.	49.	48.	48.	47.	46.	46.	45.	45.
44.	43.	43.	42.	42.	41.	41.	41.	40.	40.
39.	39.	39.	38.	38.	38.	37.	37.	37.	37.
36.	36.	36.	36.	35.	35.	35.	35.	34.	34.
34.	34.	34.	34.	33.	33.	33.	33.	33.	33.
32.	32.	32.	32.	32.	32.	32.	32.	31.	31.
31.	31.	31.	31.	31.	31.	31.	31.	30.	30.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.

STAGE

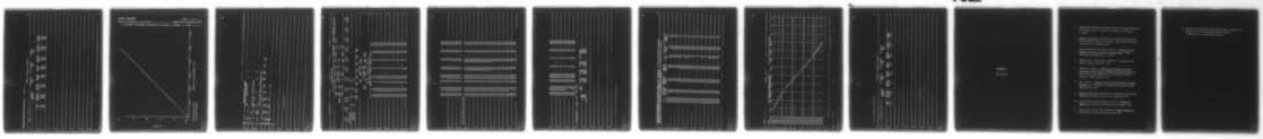
54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0
54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0
54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0
54.0	54.1	54.2	54.3	54.4	54.5	54.7	54.8	55.0	55.2
55.3	55.4	55.6	55.7	55.8	55.9	56.0	56.1	56.2	56.3
56.5	56.8	57.1	57.3	57.4	57.5	57.6	57.7	57.8	57.8
57.9	57.9	58.0	58.2	58.4	58.6	58.8	58.8	58.8	58.7
58.6	58.5	58.3	58.2	58.1	58.0	57.8	57.6	57.5	57.4
57.2	57.1	57.0	57.0	56.9	56.9	56.8	56.8	56.8	56.8
56.8	56.7	56.7	56.7	56.7	56.6	56.6	56.6	56.5	56.4
56.4	56.3	56.3	56.2	56.2	56.1	56.0	56.0	55.9	55.9
55.8	55.7	55.7	55.6	55.6	55.5	55.5	55.4	55.4	55.3
55.3	55.3	55.2	55.2	55.1	55.1	55.1	55.0	55.0	55.0
54.9	54.9	54.9	54.8	54.8	54.8	54.8	54.7	54.7	54.7
54.7	54.6	54.6	54.6	54.6	54.6	54.5	54.5	54.5	54.5
54.5	54.5	54.5	54.4	54.4	54.4	54.4	54.4	54.4	54.4
54.4	54.3	54.3	54.3	54.3	54.3	54.3	54.3	54.3	54.3
54.3	54.2	54.2	54.2	54.2	54.2	54.2	54.2	54.2	54.2
54.2	54.2	54.2	54.2	54.2	54.2	54.1	54.1	54.1	54.1
54.1	54.1	54.1	54.1	54.1	54.1	54.1	54.1	54.1	54.1

PEAK OUTFLOW IS 4982. AT TIME 17.00 HOURS

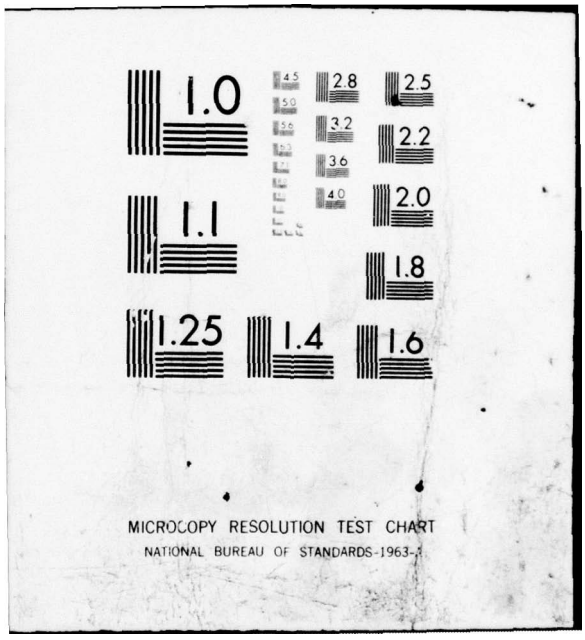
AD-A069 906 NEW JERSEY STATE DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. CLEMENTON LAKE DAM (NJ00410), DELA--ETC(U)
MAY 79 R J MCDERMOTT DACW61-78-C-0124

UNCLASSIFIED
2 OF 2
AD
A069906

NL



END
DATE
FILMED
7-79
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	54.00	54.00	56.70
STORAGE	28.	28.	79.
OUTFLOW	0.	0.	160.

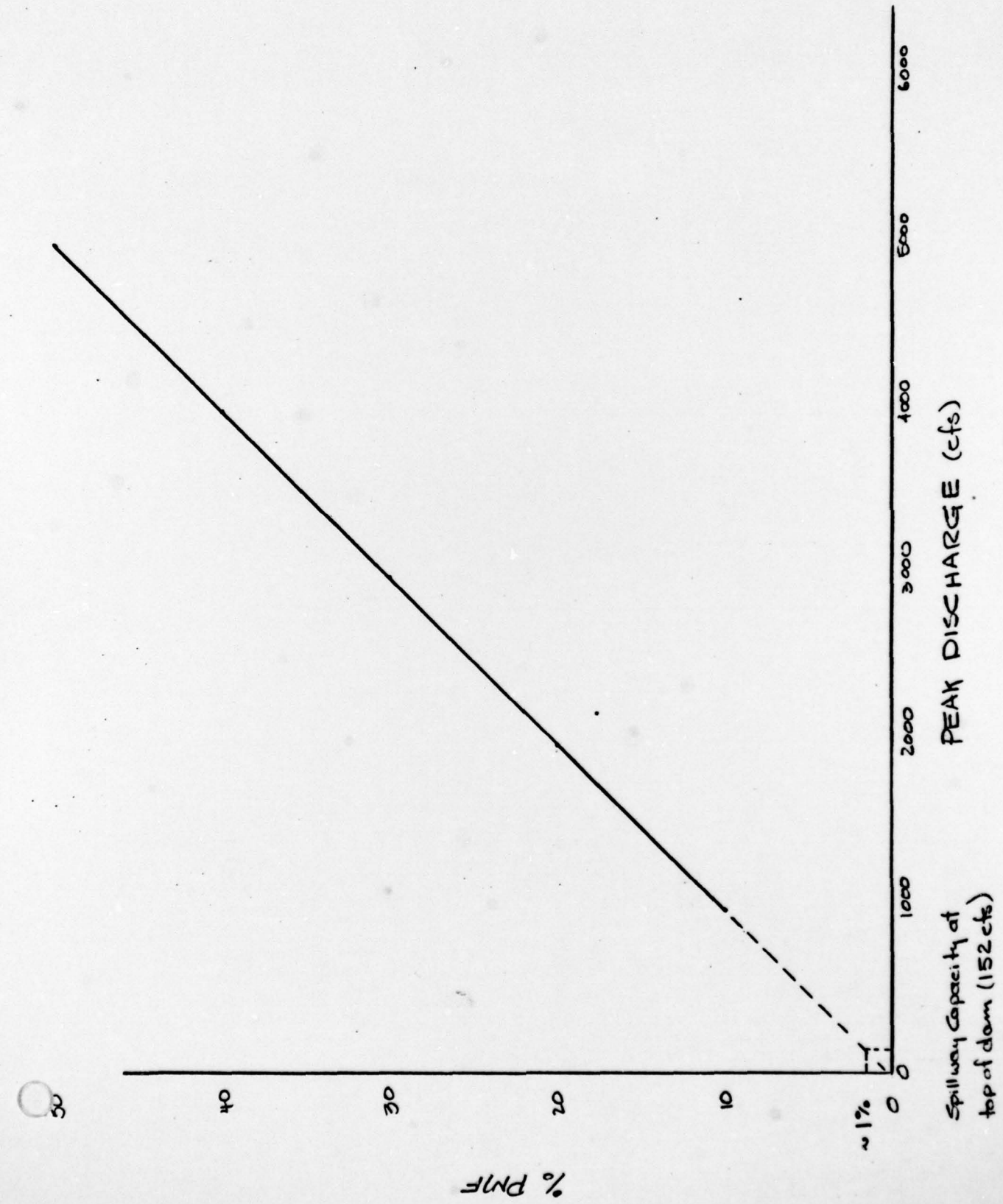
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	58.84	2.14	131.	4982.	10.75	17.00	0.00
.40	58.53	1.83	123.	3983.	9.25	17.00	0.00
.30	58.20	1.50	114.	2984.	8.25	17.00	0.00
.20	57.81	1.11	105.	1985.	7.25	17.00	0.00
.10	57.35	.65	94.	986.	5.50	17.00	0.00

STORCH ENGINEERS

Sheet _____ of _____

Project CLEMENTON LAKE DAM Made By EAW Date MAR. 26, 1979

% PMF PASSED THROUGH SPILLWAY Chkd By _____ Date _____



```
A1                                  NATIONAL DAM SAFETY PROGRAM
A2                          CLEMENTON LAKE DAM NEW JERSEY
A3                                  BREACH ROUTING
B     200         0      15                                  0       0       3
J1      5
J       1         1       1
J1    0.5
K       0      CLEM                              0       0       1
K1                          SUBAREA RUNOFF TO CLEMENTON LAKE
1       1         2     2.8                       0                       1
9       0        27     100      109      117
T                                                        1.0     0.1
J2              1.32
X    -1.0     -0.05     2.0
K       1       DAM                               0       0       1
K1                          ROUTE DISCHARGE THROUGH CLEMENTON LAKE DAM
Y                                   1       1
Y1      1                                                   -54     -1
Y4     54      54.5      55      55.5      56      56.5      57      57.5      58      60
Y5      0        15      41        74     110       151     174       199     214     276
SA      0        16      38       119
SC   48.7        54      60        70
SS     54
SD   56.7      2.63     1.5       575
SB    100         2    52.8         1      54      56.8
K      99
A
A
A
A
A
```

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE DISCHARGE THROUGH CLEMENTON LAKE DAM (0.5PMF- DAM BREACH)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	C	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-54.	-1

STAGE	54.00	54.50	55.00	55.50	56.00	56.50	57.00	57.50	58.00	60.00
FLOW	0.00	15.00	41.00	74.00	110.00	151.00	174.00	199.00	214.00	276.00
SURFACE AREA=	0.	16.	30.	119.						
CAPACITY=	0.	28.	164.	860.						
ELEVATION=	49.	54.	60.	70.						

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
54.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
56.7	2.6	1.5	575.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
100.	2.00	52.80	1.00	54.00	56.80

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

MO.DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	.15	1	.25	1.	0.	28.	54.0
1.01	.30	2	.50	1.	0.	28.	54.0
1.01	.45	3	.75	1.	0.	28.	54.0
1.01	1.00	4	1.00	1.	0.	28.	54.0
1.01	1.15	5	1.25	1.	0.	28.	54.0
1.01	1.30	6	1.50	1.	0.	28.	54.0
1.01	1.45	7	1.75	1.	0.	28.	54.0
1.01	2.00	8	2.00	1.	0.	28.	54.0
1.01	2.15	9	2.25	1.	0.	28.	54.0
1.01	2.30	10	2.50	1.	0.	28.	54.0
1.01	2.45	11	2.75	1.	0.	28.	54.0
1.01	3.00	12	3.00	1.	0.	28.	54.0
1.01	3.15	13	3.25	1.	0.	28.	54.0
1.01	3.30	14	3.50	1.	0.	28.	54.0
1.01	3.45	15	3.75	0.	0.	28.	54.0
1.01	4.00	16	4.00	0.	0.	28.	54.0
1.01	4.15	17	4.25	0.	0.	28.	54.0
1.01	4.30	18	4.50	0.	0.	28.	54.0
1.01	4.45	19	4.75	0.	0.	28.	54.0
1.01	5.00	20	5.00	0.	0.	28.	54.0
1.01	5.15	21	5.25	0.	0.	28.	54.0
1.01	5.30	22	5.50	0.	0.	28.	54.0
1.01	5.45	23	5.75	0.	0.	28.	54.0
1.01	6.00	24	6.00	0.	0.	28.	54.0
1.01	6.15	25	6.25	0.	0.	28.	54.0
1.01	6.30	26	6.50	0.	0.	28.	54.0
1.01	6.45	27	6.75	0.	0.	28.	54.0
1.01	7.00	28	7.00	1.	0.	28.	54.0
1.01	7.15	29	7.25	4.	0.	28.	54.0
1.01	7.30	30	7.50	11.	1.	29.	54.0
1.01	7.45	31	7.75	26.	1.	29.	54.0
1.01	8.00	32	8.00	48.	3.	30.	54.1
1.01	8.15	33	8.25	73.	5.	31.	54.2

1.01	8.30	34	8.50	99.	8.	33.	54.3	
1.01	8.45	35	8.75	123.	12.	35.	54.4	
1.01	9.00	36	9.00	143.	17.	37.	54.5	
1.01	9.15	37	9.25	158.	25.	40.	54.7	
1.01	9.30	38	9.50	169.	33.	43.	54.8	
1.01	9.45	39	9.75	177.	41.	45.	55.0	
1.01	10.00	40	10.00	183.	51.	48.	55.2	
1.01	10.15	41	10.25	188.	61.	51.	55.3	
1.01	10.30	42	10.50	192.	70.	53.	55.4	
1.01	10.45	43	10.75	194.	79.	56.	55.6	
1.01	11.00	44	11.00	196.	87.	58.	55.7	
1.01	11.15	45	11.25	198.	95.	60.	55.8	
1.01	11.30	46	11.50	199.	103.	62.	55.9	
1.01	11.45	47	11.75	200.	110.	64.	56.0	
1.01	12.00	48	12.00	201.	117.	66.	56.1	
1.01	12.15	49	12.25	218.	124.	68.	56.2	
1.01	12.30	50	12.50	271.	134.	70.	56.3	
1.01	12.45	51	12.75	381.	149.	74.	56.5	
1.01	13.00	52	13.00	554.	185.	80.	56.8	
1.01	13.15	53	13.25	767.	520.	87.	57.0	

BEGIN DAM FAILURE AT 13.25 HOURS

1.01	13.30	54	13.50	993.	1064.	88.	57.1	
1.01	13.45	55	13.75	1217.	1427.	85.	57.0	
1.01	14.00	56	14.00	1428.	1781.	79.	56.7	
1.01	14.15	57	14.25	1614.	2200.	69.	56.2	
1.01	14.30	58	14.50	1778.	1891.	63.	55.9	
1.01	14.45	59	14.75	1933.	1868.	62.	55.9	
1.01	15.00	60	15.00	2089.	1962.	64.	56.0	
1.01	15.15	61	15.25	2235.	2096.	67.	56.1	
1.01	15.30	62	15.50	2396.	2243.	70.	56.3	
1.01	15.45	63	15.75	2714.	2454.	74.	56.5	
1.01	16.00	64	16.00	3211.	2822.	81.	56.8	
1.01	16.15	65	16.25	3885.	3559.	88.	57.1	
1.01	16.30	66	16.50	4567.	4305.	95.	57.4	
1.01	16.45	67	16.75	4937.	4824.	98.	57.6	
1.01	17.00	68	17.00	4990.	4986.	100.	57.6	
1.01	17.15	69	17.25	4803.	4882.	99.	57.6	
1.01	17.30	70	17.50	4463.	4591.	97.	57.5	
1.01	17.45	71	17.75	4005.	4180.	94.	57.3	
1.01	18.00	72	18.00	3555.	3731.	90.	57.2	
1.01	18.15	73	18.25	3199.	3349.	87.	57.0	
1.01	18.30	74	18.50	2879.	3031.	83.	56.9	
1.01	18.45	75	18.75	2536.	2731.	80.	56.7	
1.01	19.00	76	19.00	2153.	2466.	75.	56.5	
1.01	19.15	77	19.25	1774.	2127.	68.	56.2	
1.01	19.30	78	19.50	1422.	1776.	60.	55.8	
1.01	19.45	79	19.75	1112.	1444.	53.	55.4	
1.01	20.00	80	20.00	853.	1151.	47.	55.1	
1.01	20.15	81	20.25	654.	906.	41.	54.8	
1.01	20.30	82	20.50	509.	713.	36.	54.5	
1.01	20.45	83	20.75	401.	568.	33.	54.3	
1.01	21.00	84	21.00	318.	455.	29.	54.1	
1.01	21.15	85	21.25	255.	368.	27.	53.9	
1.01	21.30	86	21.50	235.	306.	25.	53.8	
1.01	21.45	87	21.75	219.	267.	24.	53.7	
1.01	22.00	88	22.00	204.	240.	23.	53.6	
1.01	22.15	89	22.25	191.	219.	22.	53.6	
1.01	22.30	90	22.50	178.	203.	22.	53.6	
1.01	22.45	91	22.75	166.	188.	21.	53.5	
1.01	23.00	92	23.00	155.	175.	21.	53.5	
1.01	23.15	93	23.25	145.	164.	20.	53.5	
1.01	23.30	94	23.50	135.	153.	20.	53.4	
1.01	23.45	95	23.75	126.	143.	20.	53.4	
1.02	0.00	96	24.00	117.	134.	19.	53.4	
1.02	.15	97	24.25	110.	125.	19.	53.3	
1.02	.30	98	24.50	102.	117.	19.	53.3	
1.02	.45	99	24.75	95.	109.	18.	53.3	
1.02	1.00	100	25.00	89.	102.	18.	53.3	
1.02	1.15	101	25.25	83.	95.	18.	53.3	
1.02	1.30	102	25.50	77.	89.	18.	53.2	

1.02	20.15	177	44.25	0.	1.	13.	52.8	
1.02	20.30	178	44.50	0.	1.	13.	52.8	
1.02	20.45	179	44.75	0.	1.	13.	52.8	
1.02	21.00	180	45.00	0.	1.	13.	52.8	
1.02	21.15	181	45.25	0.	1.	13.	52.8	
1.02	21.30	182	45.50	0.	1.	13.	52.8	
1.02	21.45	183	45.75	0.	1.	13.	52.8	
1.02	22.00	184	46.00	0.	1.	13.	52.8	
1.02	22.15	185	46.25	0.	1.	13.	52.8	
1.02	22.30	186	46.50	0.	0.	13.	52.8	
1.02	22.45	187	46.75	0.	0.	13.	52.8	
1.02	23.00	188	47.00	0.	0.	13.	52.8	
1.02	23.15	189	47.25	0.	0.	13.	52.8	
1.02	23.30	190	47.50	0.	0.	13.	52.8	
1.02	23.45	191	47.75	0.	0.	13.	52.8	
1.03	0.00	192	48.00	0.	0.	13.	52.8	
1.03	.15	193	48.25	0.	0.	13.	52.8	
1.03	.30	194	48.50	0.	0.	13.	52.8	
1.03	.45	195	48.75	0.	0.	13.	52.8	
1.03	1.00	196	49.00	0.	0.	13.	52.8	
1.03	1.15	197	49.25	0.	0.	13.	52.8	
1.03	1.30	198	49.50	0.	0.	13.	52.8	
1.03	1.45	199	49.75	0.	0.	13.	52.8	
1.03	2.00	200	50.00	0.	0.	13.	52.8	

PEAK OUTFLOW IS 4986. AT TIME 17.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4986.	2971.	874.	421.	84132.
CMS	141.	84.	25.	12.	2382.
INCHES		9.87	11.61	11.65	11.65
MM		250.67	294.96	295.81	295.81
AC-FT		1473.	1733.	1738.	1738.
THOUS CU M		1817.	2138.	2144.	2144.

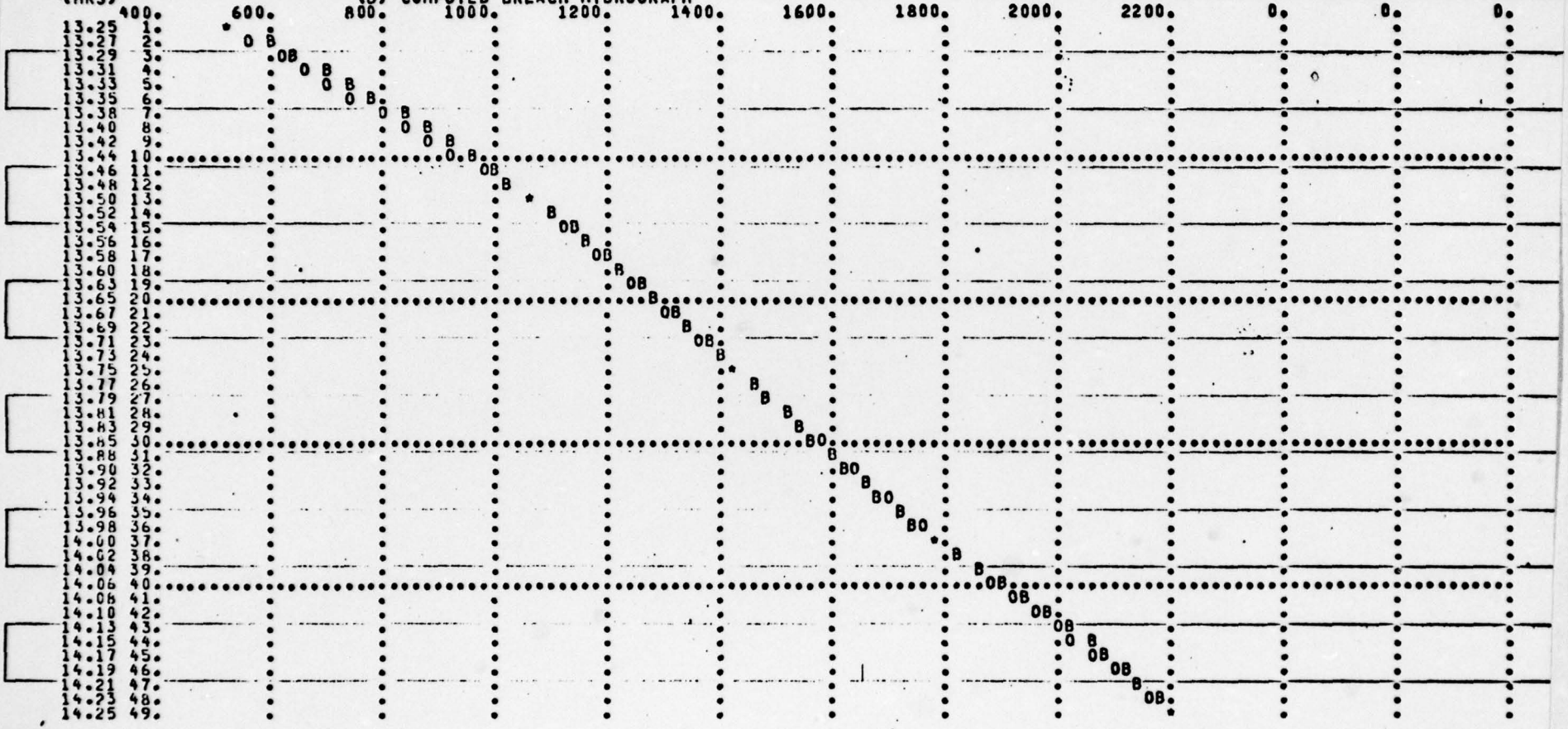
THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
13.250	0.000	520.		520.		0.	0.	0.
13.271	.021	566.		597.		-32.	-32.	-0.
13.292	.042	611.		647.		-36.	-67.	-0.
13.313	.063	656.		695.		-39.	-106.	-0.
13.333	.083	702.		743.		-41.	-147.	-0.
13.354	.104	747.		788.		-41.	-189.	-0.
13.375	.125	792.		833.		-40.	-229.	-0.
13.396	.146	838.		875.		-37.	-266.	-0.
13.417	.167	883.		916.		-33.	-299.	-1.
13.438	.188	928.		955.		-27.	-325.	-1.
13.458	.208	974.		993.		-19.	-344.	-1.
13.479	.229	1019.		1029.		-10.	-355.	-1.
13.500	.250	1064.		1064.		-0.	-355.	-1.
13.521	.271	1095.		1098.		-4.	-358.	-1.
13.542	.292	1125.		1131.		-7.	-365.	-1.
13.563	.313	1155.		1164.		-9.	-374.	-1.
13.583	.333	1185.		1195.		-10.	-383.	-1.
13.604	.354	1215.		1225.		-10.	-393.	-1.
13.625	.375	1246.		1255.		-10.	-403.	-1.
13.646	.396	1276.		1285.		-9.	-412.	-1.
13.667	.417	1306.		1314.		-8.	-419.	-1.
13.688	.437	1336.		1342.		-6.	-425.	-1.
13.708	.458	1367.		1371.		-4.	-430.	-1.
13.729	.479	1397.		1399.		-2.	-432.	-1.
13.750	.500	1427.		1427.		0.	-432.	-1.
13.771	.521	1456.		1455.		2.	-430.	-1.
13.792	.542	1486.		1483.		3.	-427.	-1.
13.813	.562	1516.		1510.		5.	-421.	-1.
13.833	.583	1545.		1538.		7.	-414.	-1.
13.854	.604	1575.		1566.		9.	-405.	-1.
13.875	.625	1604.		1594.		10.	-395.	-1.
13.896	.646	1634.		1622.		11.	-384.	-1.
13.917	.667	1663.		1652.		12.	-372.	-1.
13.938	.687	1693.		1681.		11.	-361.	-1.
13.958	.708	1722.		1713.		10.	-351.	-1.
13.979	.729	1752.		1745.		6.	-345.	-1.
14.000	.750	1781.		1781.		0.	-345.	-1.
14.021	.771	1816.		1824.		-8.	-352.	-1.
14.042	.792	1851.		1866.		-15.	-367.	-1.
14.063	.812	1886.		1906.		-20.	-387.	-1.
14.083	.833	1921.		1946.		-25.	-412.	-1.
14.104	.854	1956.		1983.		-27.	-439.	-1.
14.125	.875	1991.		2019.		-28.	-467.	-1.
14.146	.896	2026.		2053.		-27.	-494.	-1.
14.167	.917	2061.		2085.		-24.	-518.	-1.
14.188	.937	2096.		2115.		-20.	-538.	-1.
14.208	.958	2131.		2145.		-14.	-552.	-1.
14.229	.979	2165.		2173.		-8.	-560.	-1.
14.250	1.000	2200.		2200.		-0.	-560.	-1.

•OVF•

STATION DAM

(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH
(•) POINTS AT NORMAL TIME INTERVAL



SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... ELEVATION / STORAGE / OUTFLOW

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	54.00	54.00	56.70
STORAGE	28.	28.	79.
OUTFLOW	0.	0.	160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	57.60	.90	100.	4986.	4.25	17.00	13.25

APPENDIX 5

Bibliography

1. "Recommended Guidelines for Safety Inspection of Dams," Department of the Army, Office of the Chief of Engineers, Washington, D. C. 20314.

2. Design of Small Dams, Second Edition, United States Department of the Interior, Bureau of Reclamation, United States Government Printing Office, Washington, 1973.

3. Holman, William W. and Jumikis, Alfreds R., Engineering Soil Survey of New Jersey, Report No.17 Camden County, Rutgers University, New Brunswick, N. J. 1953.

4. "Geologic Map of New Jersey" prepared by J. Volney Lewis and Henry B. Kummel, dated 1910 - 1912.

5. Stankowski, Stephen J., Magnitude and Frequency of Floods in New Jersey with Effects of Urbanization, Special Report 38, State of New Jersey Department of Environmental Protecton, Division of Water Resources, 1974.

6. Herr, Lester A., Hydraulic Charts for the Selection of Highway Culverts, U.S. Department of Transportation, Federal Highway Administration, 1965.

7. Safety of Small Dams, Proceedings of the Engineering Foundation Conference, American Society of Civil Engineers, 1974.

8. King, Horace Williams and Brater, Ernest F., Handbook of Hydraulics, Fifth edition, McGraw-Hill Book Company, 1963.

9. Davis, Calvin Victor, (ed.), Handbook of Applied Hydraulics, Second Edition, McGraw-Hill Book Company, 1952

10. Construction drawing "Reinforced Concrete Deck, Clementon Lake Bridge No. 8E-10" dated December 1938, prepared by S. Herbert Taylor, Camden County Engineer.